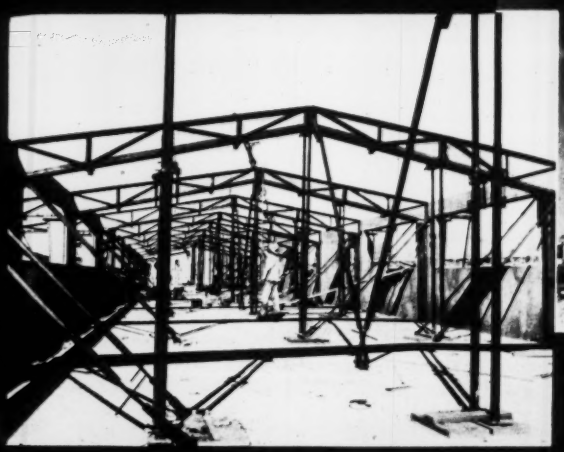
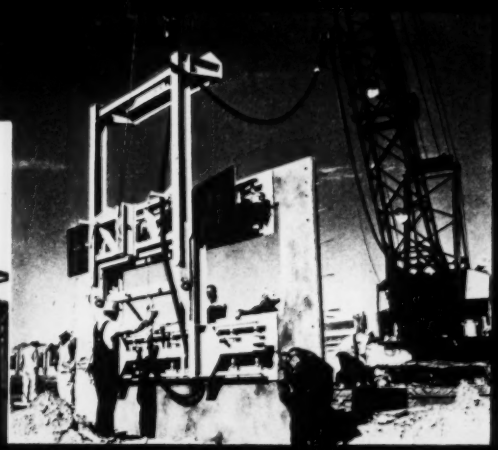
CIVIL ENGINEERING

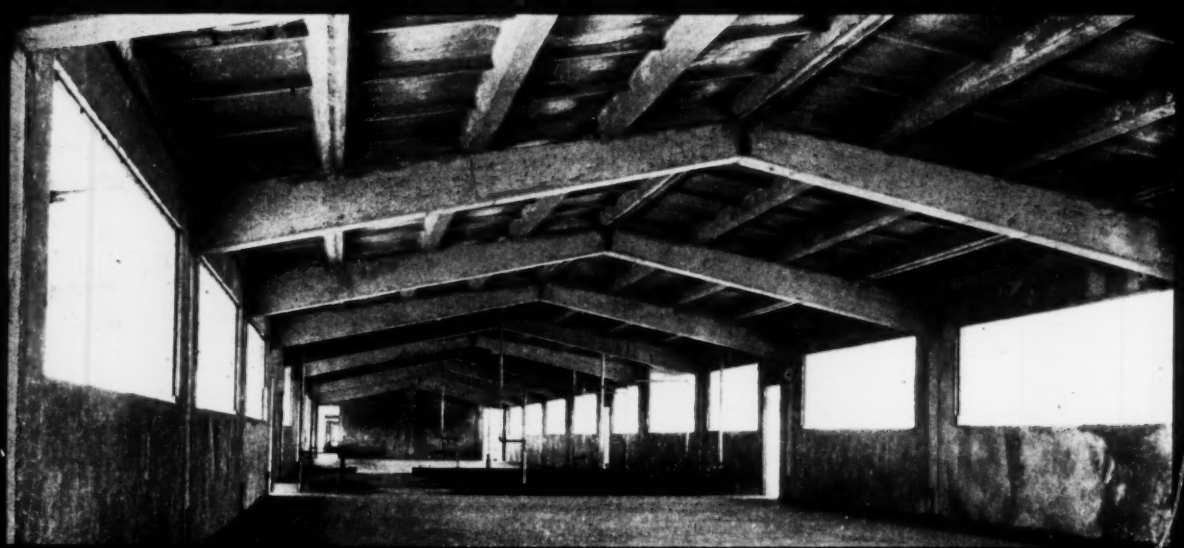
PRECAST MARINE BARRACKS

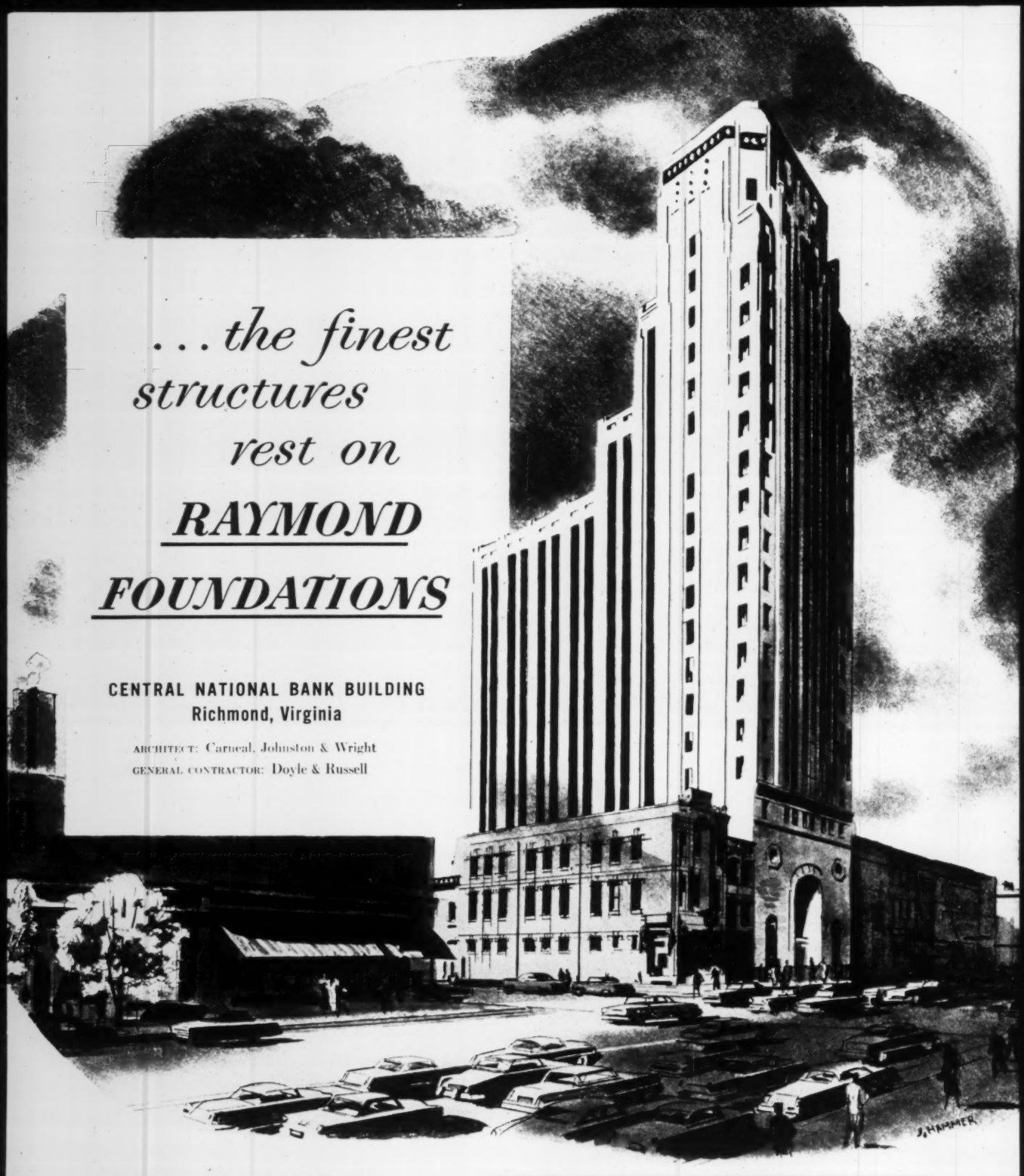
in California desert were erected at rate of two buildings a day





SEE ARTICLE BY HALL





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CENTRAL NATIONAL BANK BUILDING
Richmond, Virginia

ARCHITECT: Carneal, Johnston & Wright
GENERAL CONTRACTOR: Doyle & Russell

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Soil Investigations • Foundation Construction • Harbor and Waterfront Improvements Prestressed Concrete Construction • Cement-mortar Lining of Water, Oil and Gas Pipelines In Place.

RAYMOND'S SERVICES ABROAD . . .
In addition to the above, all types of General Construction.

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FOUNDED 1891

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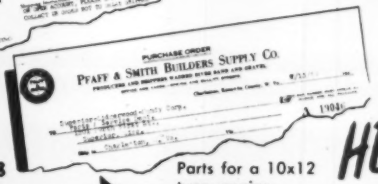
CONCRETE PILE CO.
140 Cedar Street • New York 6, N. Y.

Branch Offices in Principal Cities of the United States, Central and South America

Over half a century ago Lidgerwood made a promise

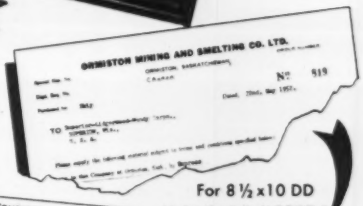
From a 1901 Lidgerwood Catalog

For 2 drum Steam Hoist #4472 —**SHIPPED 3/28/88**

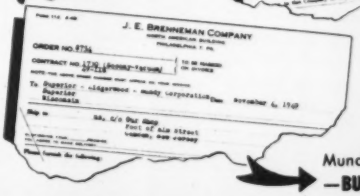


Parts for a 10x12 type engine —**BUILT IN 1889**

AND HERE'S PROOF POSITIVE



For 8 ½ x 10 DD Hoist Serial #9327 —**BUILT IN 1893**



Mundy Hoisting Machine —**BUILT IN 1892**

TODAY—we furnish parts for Lidgerwood and Mundy hoists *which were built over sixty-five years ago.* We've kept our promise! In addition, we have proved by the test of time—the toughest test of all—that Lidgerwood hoists are built to last!

Write for bulletins and catalogs!

Superior–Lidgerwood–Mundy Corporation

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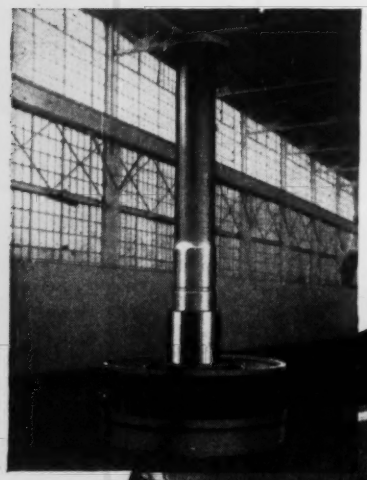
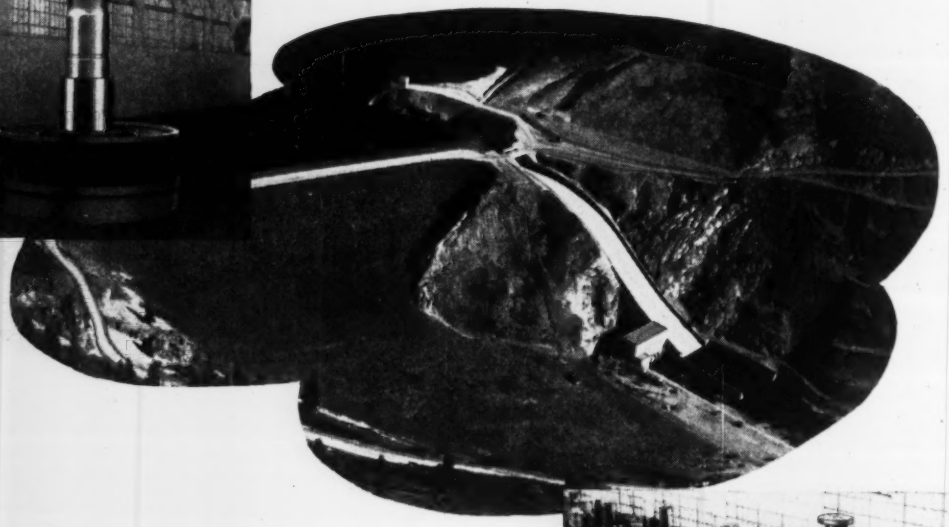
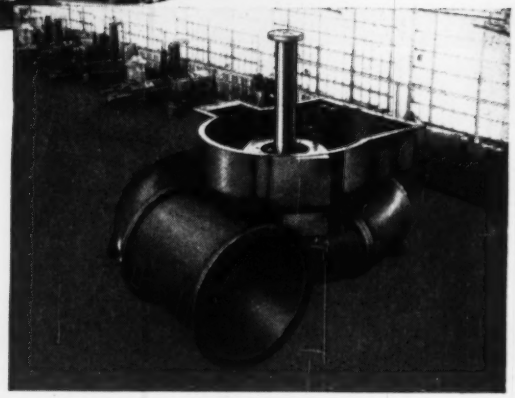


The *"Anderson Ranch"* POWER PROJECT
United States Bureau of Reclamation





hydraulic turbines by **LEFFEL**

Anderson Ranch Dam, located on the Boise River in Idaho, U. S. A., is the highest earth-fill dam in the world. Two Leffel turbines are installed in the Anderson Power Plant which provides power for the surrounding area. The turbines are of the cast steel spiral case, vertical Francis type and each is maximum rated at 28,250 HP, under 324 ft. net head, speed 277 RPM.

With a structural height of 456 feet, a base width of 2,650 feet and a crest length of 1,350 feet the Anderson Ranch Dam contains nearly 10,000,000 cubic yards of earth and rock. The reservoir behind the dam will hold 493,200 acre-feet of water.

When you consider turbines for your power project (whether it is a new installation or the expansion of an existing installation) we ask you to keep in mind the services which are offered by Leffel. Our 91 years of experience, our large modern plant, our thorough workmanship — all are ready to serve you.

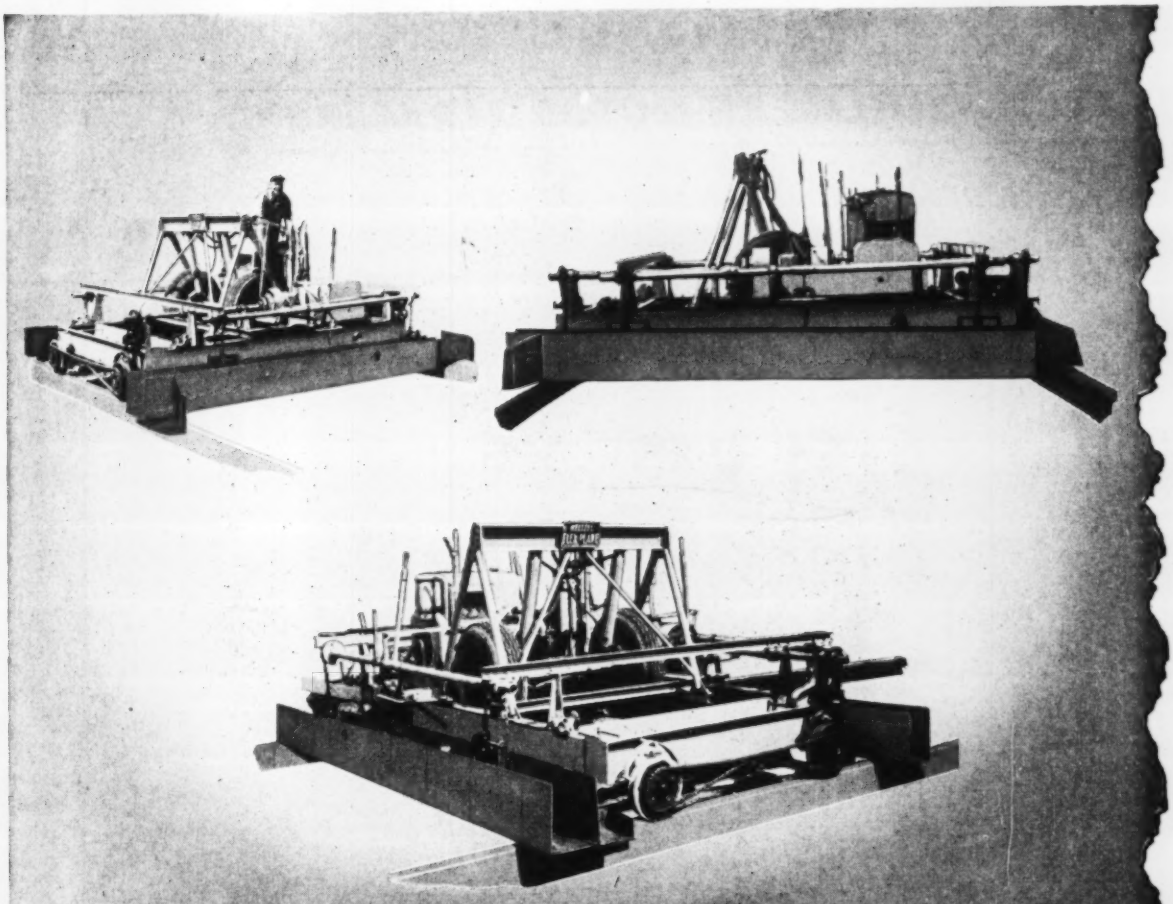
1083

FOUNDED IN 1862

THE JAMES LEFFEL & CO.

DEPARTMENT C • SPRINGFIELD, OHIO, U.S.A.

MORE EFFICIENT HYDRAULIC POWER FOR 91 YEARS



YOU'RE LOOKING AT THE MOST MOBILE CONCRETE FINISHER IN THE WORLD . . . .

Here are three views of one of the most heralded machines in highway and airport construction history. It's the super portable Flex-Plane Detroit Special Finishing Machine.

Wherever one of these machines is in operation you'll discover the contractor using the machine has been able to work faster at less cost.*

Completely portable, the machine will lift itself from the forms and convert itself into a "trailer" in a minute . . . ready to be taken to the next job with a minimum of make-ready and idle crew time.

THE SUPER PORTABLE FLEX-PLANE DETROIT SPECIAL

Special screeds and screed mounts enable this speedy machine to finish any type surface in the manner specifications call for. Both screeds are mounted outside the frame which permits faster screed changes. Machine is telescopic . . . can be altered to fit any size job in approximately 15 minutes. If you are in the business of building concrete streets, highways or landing strips, you can't afford to overlook this cost-cutting finisher. To get all the facts drop a note on your company letterhead to the **Flexible Road Joint Machine Company, Warren, Ohio, today.**

** Ask for name of contractor nearest you operating a Detroit Special — talk to him about the quality of work, the speed and the savings he has been able to get by using this great machine.*

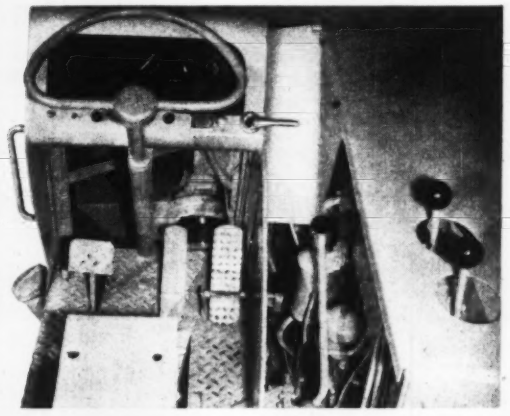
ALLIS-CHALMERS *MOTOR SCRAPERS*

FULL CONTROL makes

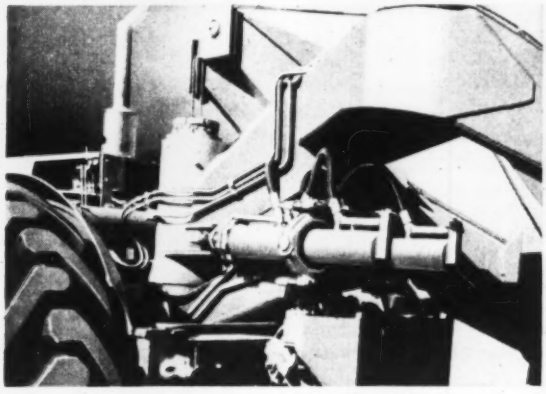
TS-300 IN ACTION
14 cu. yd. struck capacity
18 cu. yd. heaped capacity
280 hp. Buda diesel or
275 hp. Cummins diesel

the difference

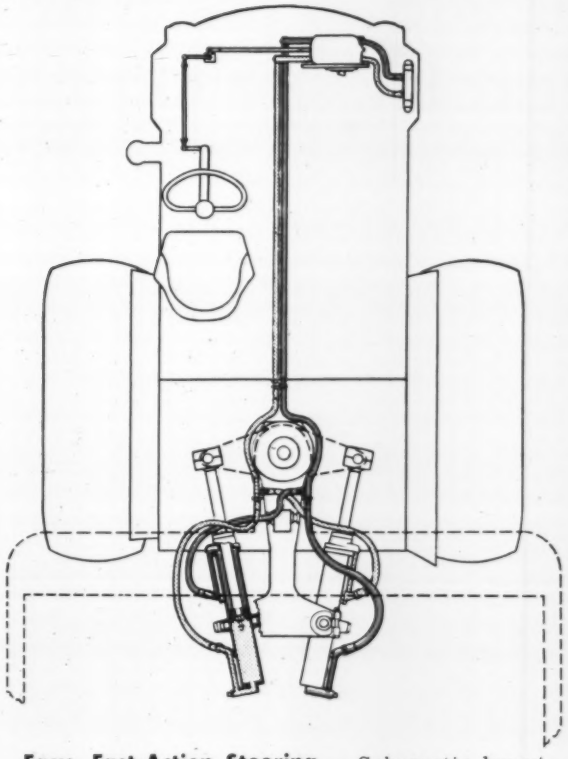
The full control built into Allis-Chalmers *Motor Scrapers* offers you a real advantage. There's no tiring wheel fight for the operator . . . no straining to see what he's doing. What's more, full control creates greater confidence when he's high-balling a full load. He can work at his best all day long easily and safely. To you owners, that means moving *more* dirt *faster*, more *profitably*.



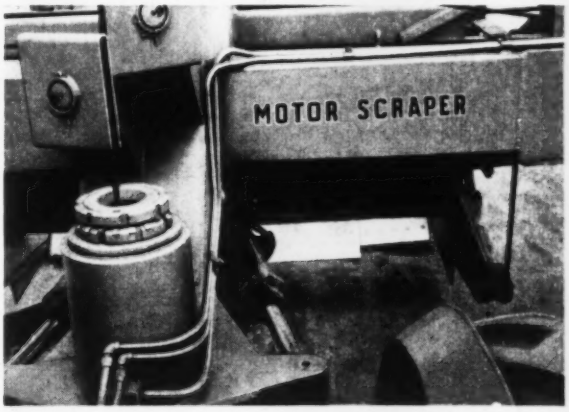
One Hand Does the Steering—the other handles the scraper controls. Fast action makes loading easy. The operator can utilize hydraulic power of steering jacks to pull through soft spots in haulways under extreme conditions.



No Weaving—No Road Shock — Hydraulic system is locked and the *Motor Scraper* becomes a rigid 4-wheel unit except when steering wheel is turned, thus eliminating transmission of road shock to steering wheel. Low-mounted rams, close to load line pull, mean minimum stress on the kingpin.



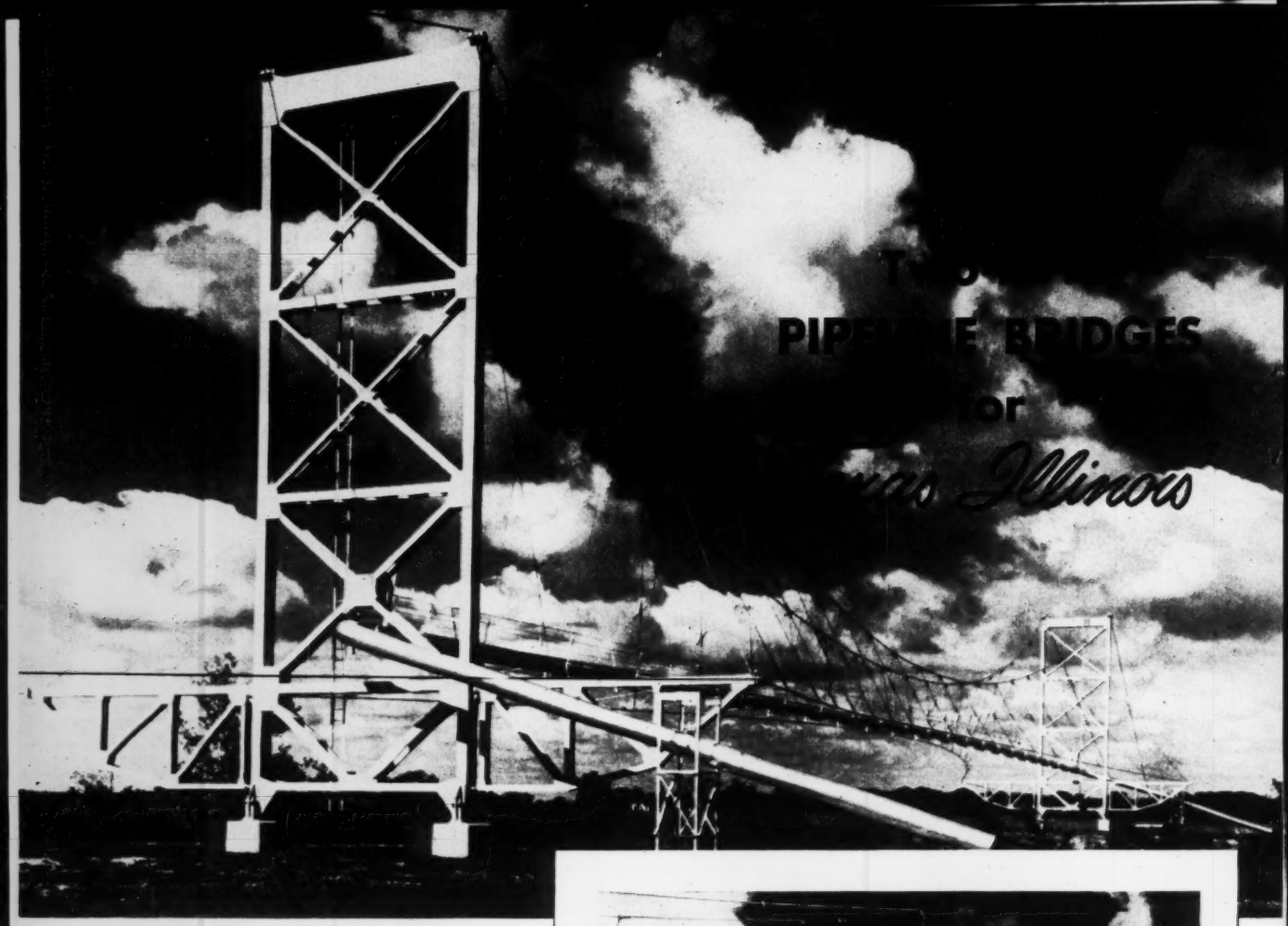
Easy, Fast-Action Steering — Schematic layout shows simple double-action steering system. Slightest movement of wheel opens valve of gear-type pump; release wheel and valve automatically returns to "hold." Only a one-third turn of steering wheel is necessary for a full swing of the tractor.



Excellent Operator Visibility — Clean design of low gooseneck connection gives operator unequalled view of cutting edge, helps him cut cleanly, efficiently . . . load fast and full.

Your nearby Allis-Chalmers dealer will be glad to show you and give you the full story on these job-proved *Motor Scrapers*. See them at work.

ALLIS-CHALMERS
TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

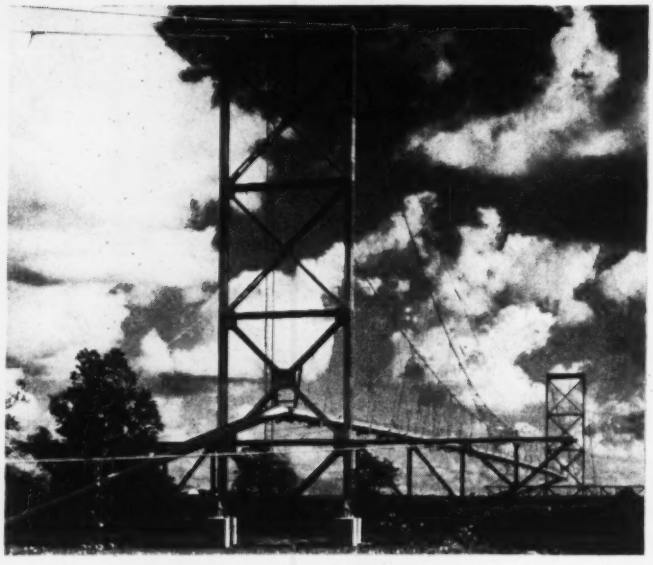


Colorado River Bridge, near Glenflora, Tex., carrying Texas Illinois 26" O.D. gas pipeline. Main span of 550' has provision for a second line.

by

PITTSBURGH-DES MOINES

These two modern Pipeline Bridges were constructed by Pittsburgh-Des Moines for the Texas Illinois Natural Gas Pipeline Company, Chicago, Ill. Typical of the many stream crossings built by us for the great pipeline companies in recent years, these bridges exemplify our special capacity and experience in this field. Let us discuss your future projects.



Brazos River Bridge, near Simonton, Tex. 750' main span carries Texas Illinois 30" gas pipeline, and is designed for future additional line.

These bridges were designed by Matthews & Kenan, consulting engineers of San Antonio, Tex.

PITTSBURGH • DES MOINES STEEL CO.

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AMERICAN DOUBLE-X Mechanical Joint Pipe

The above illustration shows an outfall sewer line at Dunedin, Florida, which was constructed of 20″ American Double-X mechanical joint pipe. It extends about one quarter mile into St. Joseph Sound for disposal of the effluent from the sewage disposal plant. The assembled pipe line was floated out from shore with a bulldozer supplying the thrust at the shore end.

Manufactured under rigid specifications in diameters 3″ through 48″, American Double-X pipe will stand the impact of heavy loads and gives complete job satisfaction. American Double-X pipe is conveying water, gas, crude oil, gasoline, sour naphtha, sewage, salt brine—and in fact, just about everything that a pipe line can conceivably convey. It is conveying these products under operating pressures ranging from a few pounds to the square inch, up to pressures in excess of 100 pounds gas and 500 pounds liquid.

Write for American Double-X pipe booklet. A free copy will be sent on request.

AMERICAN CAST IRON PIPE COMPANY

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American Cast Iron Pipe Company,
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Gentlemen: Please send me a free copy of your new illustrated booklet *"American Double-X Mechanical Joint Pipe."*

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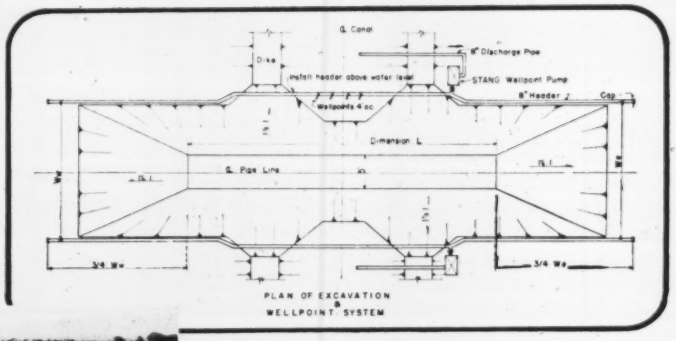
BEATING a DEADLINE

Contractor used Stang service and Stang know-how

In connection with the installation of a 30 inch gas pipe line at Blythe, California, it was necessary to install crossings under the Palo Verde Irrigation Canal System at nine separate locations.



The Installation ↓

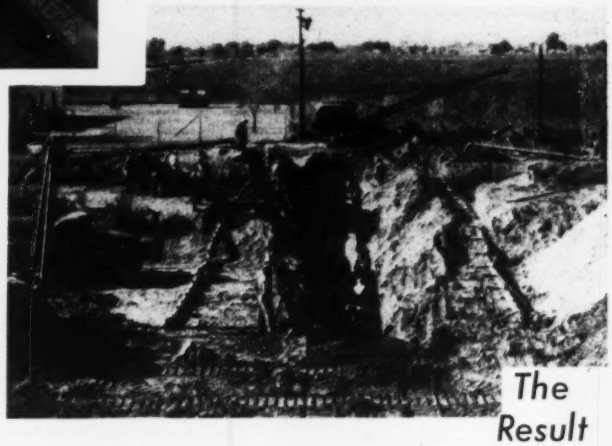
The Specification

Time allowed for the entire operation was the month of December, 1952. Allowable time out of operation per crossing was 72 hours. Fully saturated fine silt predominated throughout the area. The non-consolidating nature of the material made it impractical to excavate and properly compact backfill without dewatering.

Using two complete STANG WELLPOINT SYSTEMS, the contractor was enabled to complete the entire operation in 27 calender days, with a maximum out-of-service of 48 hours!

Attesting to service and know-how of the STANG organization are Palo Verde Irrigation District, Mr. O. E. Summers, Ch'f Eng'r. Southern Counties Gas Company of California, Mr. J. Binkley, Ch'f Eng'r.

Pacific Pipeline and Construction Company, Gen. Contractors, "Bud" Abernathy, Proj. Supt.



The Result

JOHN W. STANG CORPORATION

Engineers and Manufacturers of Dewatering Equipment

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P. O. Box 631 Telephone: Logan 5-7421

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Telephone: Walnut 7796

NEW YORK CITY, NEW YORK
Number Two Broadway
Telephone: Whitehall 3-0565

TACOMA, WASHINGTON
2339 Lincoln Avenue
Telephone: Broadway 4362

Lithographed on stone for U. S. Pipe and Foundry Co. by John A. Noble, A. N. A.

THIS ILLUSTRATION showing the installation of U.S. mechanical joint pipe in a residential area is a typical scene. It could be either a water, gas or sewer line installed to furnish reliable utility service for present and future generations in the community.

U.S. cast iron pipe centrifugally cast in metal molds is a quality product produced by a modern casting process which is carefully controlled from raw material to the finished pipe.

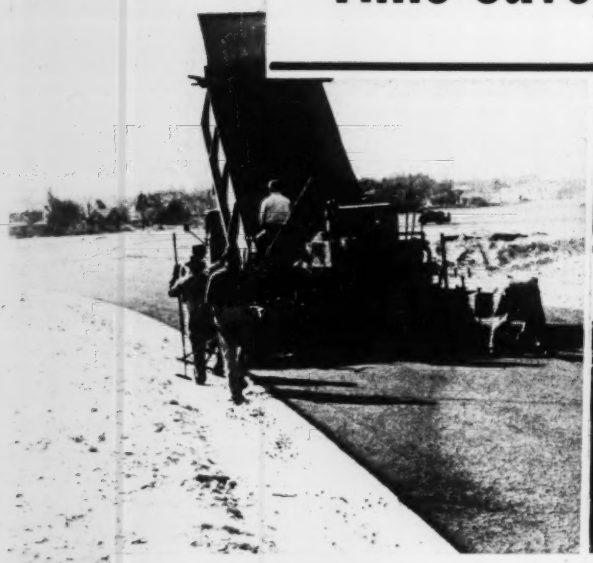
We are well equipped to furnish your requirements for cast iron pipe and fittings made in accordance with American Standard, American Water Works Association and Federal specifications. U.S. pipe centrifugally cast in metal molds is available in sizes 2- to 24-inch and pit cast pipe in the larger sizes.

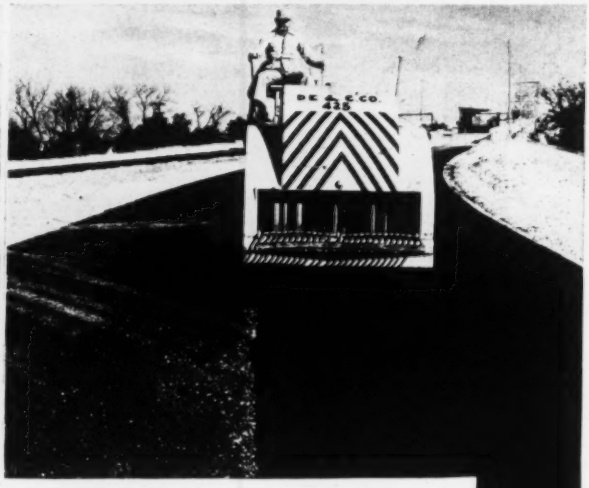
United States Pipe and Foundry Co.,
General Office, 3300 First Ave., N. • Birmingham 2, Ala.
Plants and Sales Offices Throughout the U.S.A.

U.S.
cast iron
PIPE

Our General Office is now located in Birmingham, Ala., instead of Burlington, N. J.

Time saver for Florida traffic





Jacksonville's new express highway system

Now served by 500,000 sq. yds. of hot-mix Texaco Asphalt Concrete

Hot-mix Texaco Asphaltic Concrete being laid over a limerock foundation on approach to John E. Matthews Bridge, which spans St. John's River in Jacksonville. This and other sections of new expressway system at Jacksonville were constructed by Duval Engineering and Contracting Company of that city.

For two years, the Florida State Road Department has been constructing an elaborate expressway system, which is designed to speed the flow of through traffic converging on the city of Jacksonville from all directions. Approximately a third of the project has been completed to date.

One of the newest and most important links in this long-range program is the western approach to the John E. Matthews Bridge over the St. John's River. To cope with the heavy traffic anticipated on this approach, two courses of hot-mix Texaco Asphaltic Concrete, with a compacted thickness of two inches, are being laid over a limerock foundation ten to twelve inches thick. Up to the present time, more than 500,000 square yards of Jacksonville's expressway system have been paved with Texaco Asphaltic Concrete on either a limerock or a shell foundation

For less heavily traveled sections of the system, sand bituminous construction of the road-mix type has been employed, using Texaco Cutback Asphalt as binder.

From Florida to New England and west to the Rockies, road builders have been relying on the dependable performance of Texaco Asphalt products for 50 years. Refined exclusively from carefully selected crudes, these Asphalt Cements, Cutback Asphalts and Slow-curing Asphaltic Oils supply answers to every road and street need, from heavy-duty pavements to inexpensive, waterproof mats.

Two booklets, which supply helpful information about the various types of Asphalt construction, can be obtained by interested road builders without obligation by writing our nearest office.

THE TEXAS COMPANY, Asphalt Sales Dept., 135 E. 42nd Street, New York City 17

Boston 16 • Chicago 4 • Denver 1 • Houston 1 • Jacksonville 2 • Minneapolis 3 • Philadelphia 2 • Richmond 19

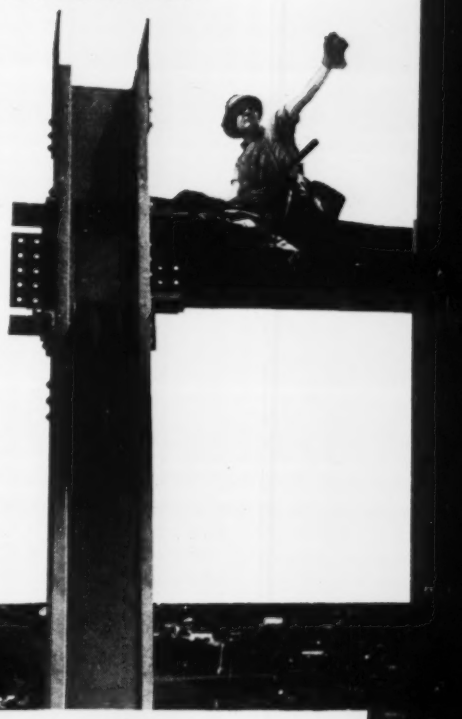
TEXACO

REG. T. M.

TEXACO ASPHALT

IN PITTSBURGH'S GOLDEN TRIANGLE . . .

34,200 Tons of Steel Frame Construction by AMERICAN BRIDGE in 24 months!



PITTSBURGH'S new buildings have been the talk of the business world. Few cities anywhere have experienced as much commercial construction in so short a time.

For example, in the famous Golden Triangle, busy hub of this hustling metropolis, American Bridge alone erected 34,200 tons of steel framework for six towering new buildings in the two year period between April 3, 1950 and March 31, 1952.

American Bridge fabricated and erected all structural steel for the 41-story building known as 525 William Penn Place; the 31-story Alcoa building; the three Gateway Center buildings (one of which is 24-stories, and two 20-stories); and the 20-story Bigelow Apartment House.

Such an accomplishment is unusual only in the fact that all buildings are located in the downtown area of a single city . . . and that all were under construction at practically the same time. The interesting point is that one company had the facilities, the skilled manpower, and the engineering know-how to handle six sizable jobs like these with such speed and efficiency without disrupting the time schedule of the numerous other construction projects which it was handling in other parts of the country.

It only goes to prove that no job is too large for American Bridge. If you would like to know more about the advantages of American Bridge fabricated and erected construction, call our nearest office.

RECENT ADDITIONS TO PITTSBURGH'S SKYLINE

525 William Penn Place
14,000 tons of Structural Steel

Alcoa Building
6,400 tons of Structural Steel

Gateway Center Buildings (3)
12,000 tons of Structural Steel

Bigelow Apartment House
1,800 tons of Structural Steel

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
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AVAILABLE NOW! *For showing in churches, schools, clubs and industries, the new sound and color motion picture— BUILDING FOR THE NATIONS — a candid, factual photographic record of the highlights of the fabrication and erection of the United Nations Secretariat Building.* For free bookings, write Pittsburgh office.

AMERICAN BRIDGE

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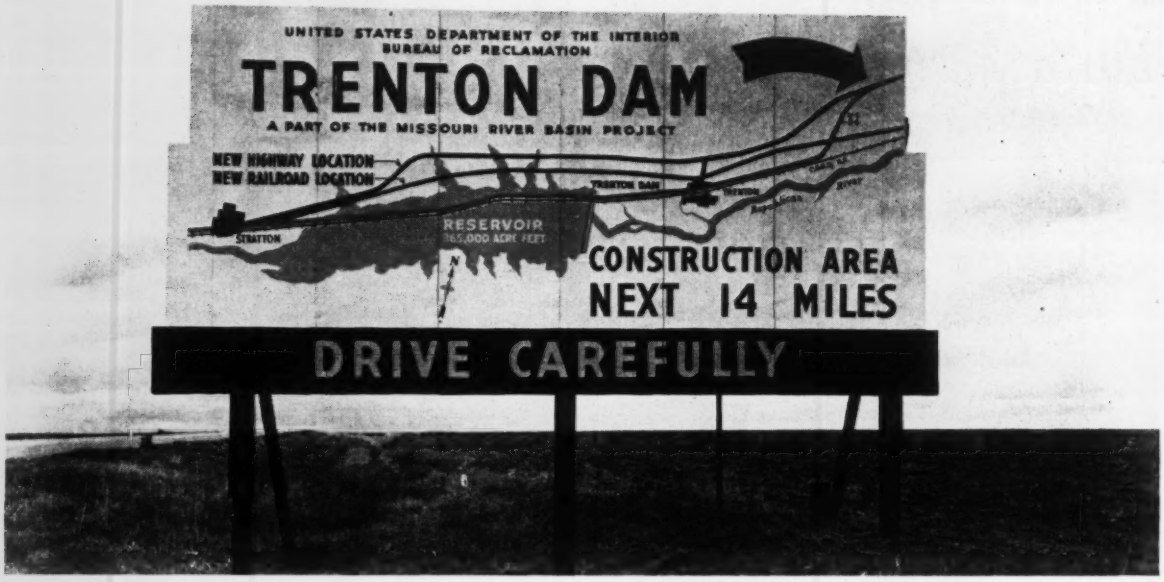
UNITED STATES STEEL

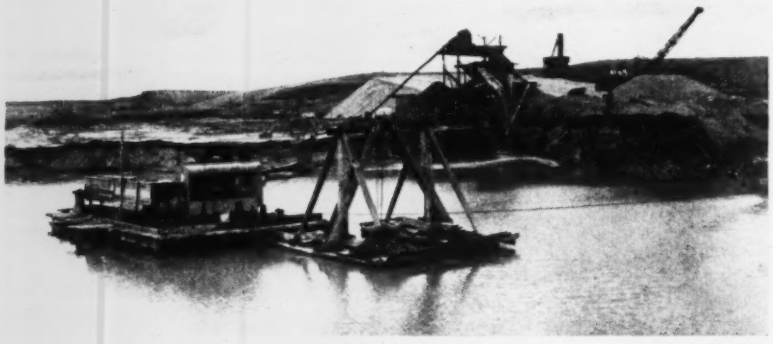
CATERPILLAR



$23,000,000 PROJECT with a Billion-dollar Benefit

Now about 90 per cent completed, the Trenton Dam, in southwestern Nebraska near the Kansas line, promises to return many times its cost to the farmers and taxpayers of the Great Plains area.

In the past 20 years alone, the rampaging Republican River has caused losses by flood damage far greater than the total cost of the new construction. But flood control is only one of the advantages brought by the dam. Erosion and wind have made this part of the country a typical dust-bowl region, and many thousands of acres of land will soon be made fertile by irrigation. The reservoir behind Trenton Dam will have a shore line of 45 miles and a capacity of 365,000 acre-feet. It will provide fishing and other recreational facilities and will be an aid to wildlife propagation.



This 8-inch dredge pump is powered by a Caterpillar D13000 Engine. Owner A. L. Davidson, of Davidson-Merritt, Indianola, Nebraska, says: "From every angle, Caterpillar Engines are the best and most economical we have ever had in 25 years' experience."

A Caterpillar D8 Tractor with No. 8A Bulldozer feeds loose material to the P&H 5-yard dragline, powered by a Cat D375 Engine. Owned by Vinnell-United-Bell, Trenton, Nebraska.

The project is under the control of the U. S. Department of the Interior, Bureau of Reclamation. It involves a large number of major contracts, not only for building the dam itself but for railroad and highway relocation and irrigation canals.

Of rolled earthfill construction, the dam is 9,000 feet long, 800 feet wide at the base and 30 feet at the crest. Its volume is 8,000,000 cubic yards. In addition, more than 10,000,000 cubic yards of material must be moved to complete other parts of the project.

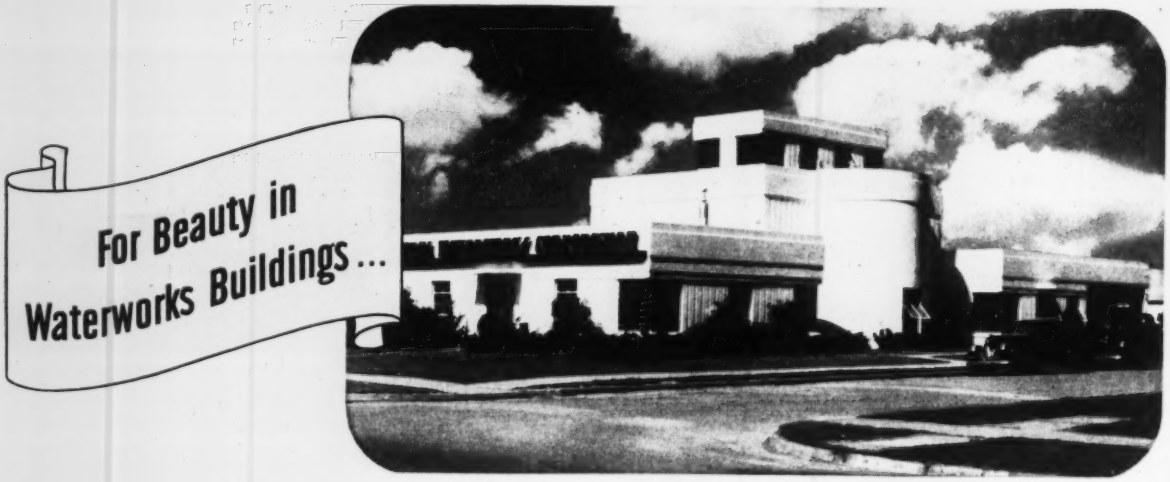
As on every big job of this kind, Caterpillar* Equipment is much in evidence. Excavators, compressors, dredges and crushers are powered by Caterpillar Engines. Cat* Diesel Tractors and Motor Graders are used for bulldozing, hauling and road maintenance.

Most of these contractors have proved by long experience that standardizing on the big yellow machines is profitable. Under dusty conditions such as prevail here, Caterpillar filters, seals, air cleaners and other exclusive design features offer top protection against clogging, abrasion and resultant down time. The problem of stocking parts is simplified by standardization. And service by a single nearby dealer, backed by the resources of one responsible manufacturer, helps keep the machines steadily at work.

A rock-crushing plant near Trenton Dam is powered by a Cat D17000 Engine. This plant, and the D6 working in foreground, are owned by C. L. Hubner Co., Denver, Colo.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

*Both Cat and Caterpillar are registered trademarks—®



For Economy in Both Choose Concrete

Using concrete in both water lines and waterworks buildings helps a community get good service and low rates for domestic and industrial users.

Concrete pipe has the durability that enables it to render long service in water lines. It has the strength to resist severe impact and carry heavy overburdens. It is not subject to internal corrosion resulting from tuberculation or electrolytic attack. This insures constant hydraulic efficiency. Concrete pipe stays clean, too, thus minimizing taste and odor problems and the unsightly staining of enamel plumbing fixtures. And the tight joints plus the uniformly dense structure of concrete pipe assure satisfactory watertightness.

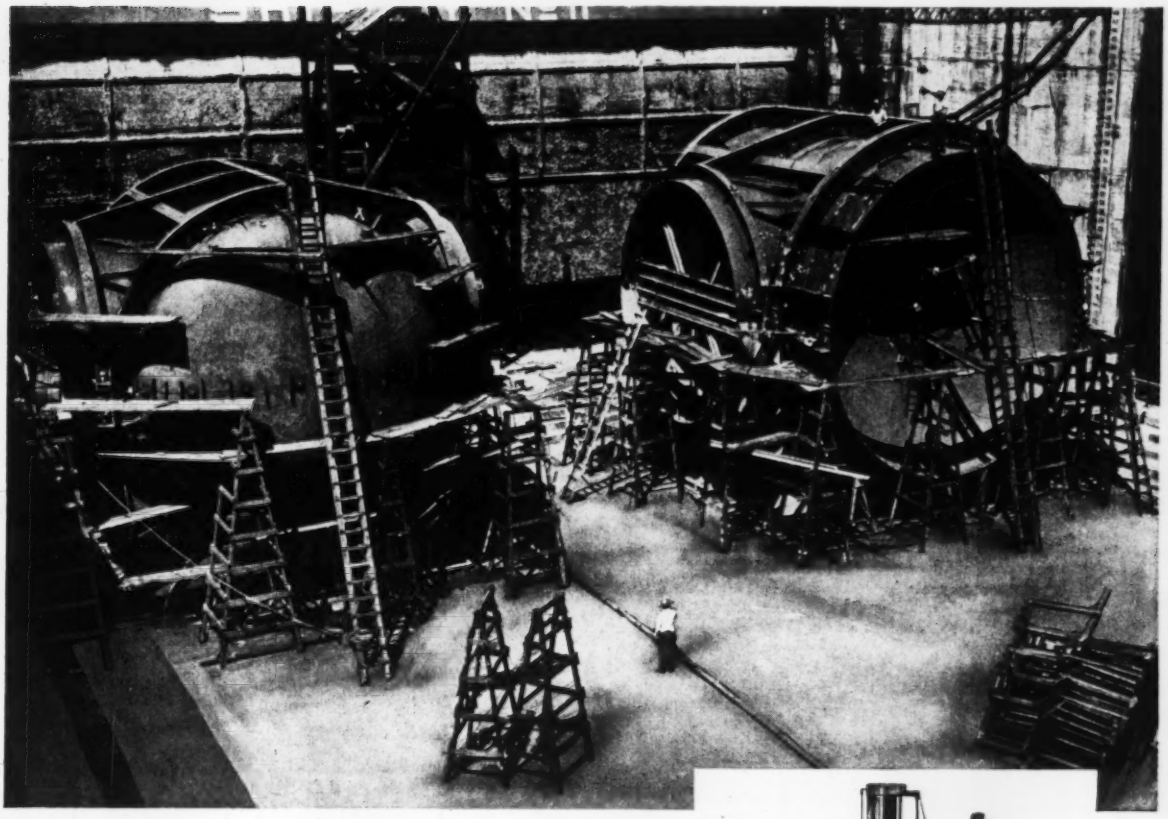
Architectural concrete is ideal for waterworks structures. As in the Pine Bluff, Ark. General Waterworks plant shown above it can be used to create buildings that are both functional and distinctive. Such buildings stand out as symbols of sanitation and good management and are a source of community pride. Architectural concrete meets all structural requirements for durability, fire-safety and strength and can be molded economically into ornamentation of any style or period.

Concrete is economical construction both in water lines and waterworks buildings. It is moderate in first cost, costs less to maintain and lasts longer. The result is ***low-annual-cost*** service.

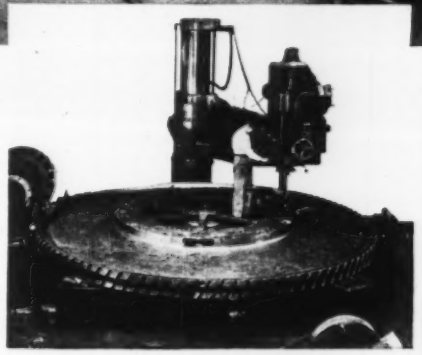
PORTLAND CEMENT ASSOCIATION

33 WEST GRAND AVENUE, CHICAGO 10, ILLINOIS

A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work



ASSEMBLING FLOW DIVERSION VALVES of an 8-foot supersonic wind tunnel for the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.



DRILLING A 25-TON FORGING . . . one of 11 alloy steel discs used in one of the two axial flow compressors which Newport News is constructing for the NACA's Ames laboratory.

Man-made Hurricanes

PUSH A BUTTON . . . That's all it will take to accelerate wind up to several times the speed of sound in a new supersonic wind tunnel at the Ames laboratory of the National Advisory Committee for Aeronautics, in Moffett Field, California.

The tunnel is designed to develop new aerodynamic information. Its heart is the "windmaker" . . . two axial-flow compressors which look like a giant tube 50 feet long and 24 feet in diameter, studded with small blades.

Because of the size of this unit, it is significant that the task of building these mammoth compressors was assigned to Newport News.

Newport News has also constructed two diversion valves, similar to huge plug valves, for diverting the air flow from one channel of the tunnel to another, as desired.

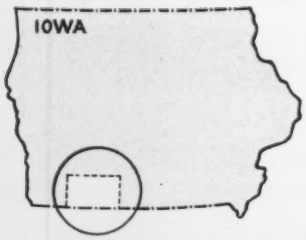
Large engineering and technical staffs, operating a plant with acres of brass, iron and steel foundries, five huge machine shops and other extensive fabricating facilities, make Newport News an ideal source for large equipment . . . *standard or special in design.*

Products ranging from components of rayon spinning machines to giant 165,000 horsepower hydraulic turbines operating at Grand Coulee, reflect Newport News' high integration of skill and production facilities.

Consult us on equipment for your present or future projects. Write today for your copy of "*Facilities and Products.*"

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
Newport News, Virginia

Taking Iowa



RINGGOLD COUNTY has 935 miles of county roads. This is the location of farm to market road construction done by the International Crawler fleet of Easter & Schroeder, Inc.

Pick Your Site and Set Your Hour...
We'll Demonstrate Our Tractor's Power

"IDEAL FOR FARM-TO-MARKET ROAD CONSTRUCTION," say Joe Easter and Don Schroeder (above). "In our eight month's working season, our five TD-18A units, with the sixth as a pusher, moved approximately 540,000 cubic yards, with minimum downtime."

ROAD BUILDING PRODUCTION LINE! Part of the Easter & Schroeder fleet of International crawlers on a regrading job in Ringgold County, Iowa. On this seven-mile stretch they moved 78,000 cubic yards in three weeks' time. *"We move it that way all the time,"* say the owners.

to Town

Farm-to-market roads get big boost fast from the International Crawler fleet of Easter & Schroeder, Inc.

The dirt flies when Easter & Schroeder, Inc., move in with their fast, powerful fleet of International crawlers . . . and Iowans can get to town and back in time to do the milking. For these Griswold, Iowa, contractors specialize in farm-to-market roads in the tall corn state.

Take the seven-mile job in Ringgold County, Iowa, you see here. In three weeks' time, Easter and Schroeder moved 78,000 cubic yards of dirt to give the road a 24-foot top on a 66-foot right of way.

Easter and Schroeder came to this Ringgold County job from one in Taylor County, where they moved 35,000 cubic yards of dirt on a two-mile stretch, completing the job in six 11-hour days.

"After 25-years' experience working in dirt, we settled on a crawler fleet one hundred per cent International," say these contractor partners. The fleet now consists of six International TD-18As with scrapers and 'dozers and a TD-14A with tamping roller.

Do you want speed and dependable economy under tough conditions? Then get in touch with your International Industrial Distributor, for all the facts on Power that Pays!

INTERNATIONAL HARVESTER COMPANY, CHICAGO 1, ILL.

POWER THAT PAYS

INTERNATIONAL

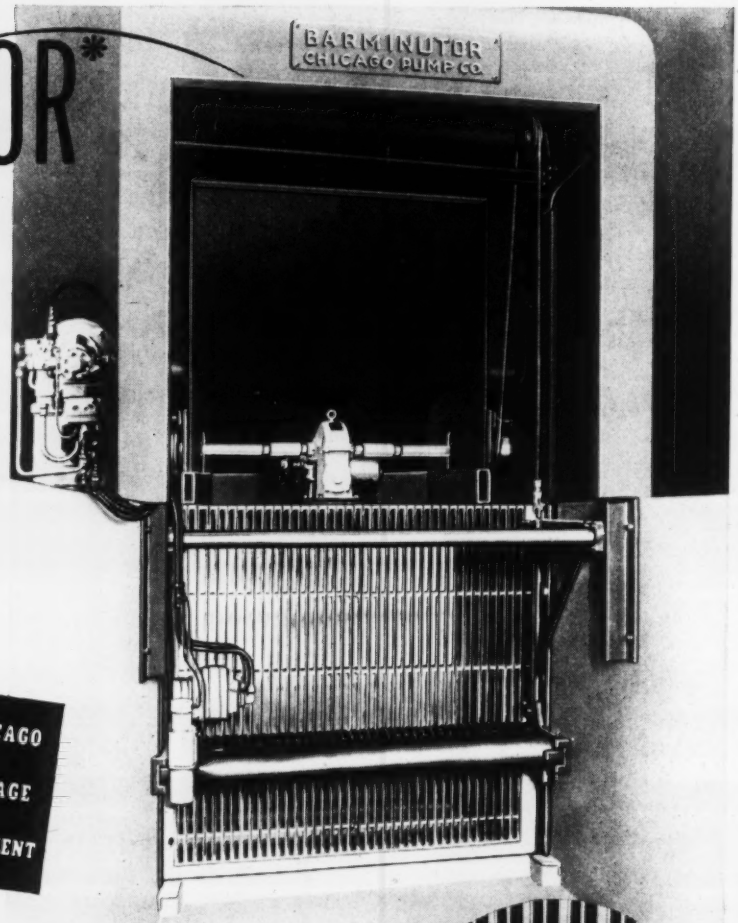
INTERNATIONAL HARVESTER

TD-6 TD-4 SEVEN GREAT INTERNATIONAL CRAWLERS...EACH WITH MATCHED EQUIPMENT FOR EVERY JOB

BARMINUTOR*

A New Comminution Development

CHICAGO SEWAGE EQUIPMENT



Barminutor installed in 5' channel.

The Barminutor Model "A" exclusively provides the advantages of comminution with maximum economy for flows from 10 to 15 M.G.D. Screening and cutting of coarse sewage material is accomplished without removal from the flow, maintaining continuous cleaning of the screen. The Barminutor, developed and tested over five years, based on fifteen years successful experience with the Comminutor, eliminates odors and handling nuisance in the screening process. High rate cutting in the flow—comminution—provides low maintenance cost and long life for cutting parts.

In tests conducted on a Barminutor installed at the Indianapolis, Indiana Sewage Treatment Plant, the unit was subjected to test loads of screenings up to six times normal load for 40 M.G.D. This material was comminuted and the screen completely cleaned in six minutes. Even with this heavy load head loss through the screen did not exceed 6". Like the Comminutor, power requirements are low.

FUNCTION OF THE BARMINUTOR

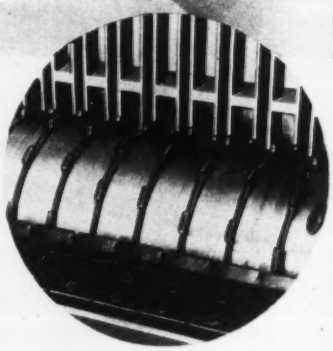
1. Cleaning the ¾" vertical bar screen and cutting of the screenings is accomplished by continual travel of the comminuting unit at 8 ft. per minute. Both upward and downward travel is controlled by an electric reversing brake motor.

2. The cutters on the comminuting unit, rotating at 400 R.P.M., travel within slots of the U-shaped bars and carry coarse material to the combs for cutting.

3. The direction of rotation automatically reverses when the direction of travel changes. The combs automatically position themselves to accomplish rapid cutting for each direction of rotation.

4. Uncuttable material is automatically rejected without damage to the cutting parts.

5. Rotation of cutters, position of combs and rejection of uncuttable material is accomplished through oil powered hydraulic system.



Close-up of Cutters and Combs. Cutters rotate within slots of Bar and Comb.

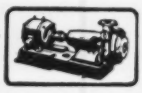
**Chicago Pump Company's trade name for its new screening and comminuting device for large sewage flows from 10 M.G.D.*

CHICAGO PUMP COMPANY

SEWAGE EQUIPMENT DIVISION

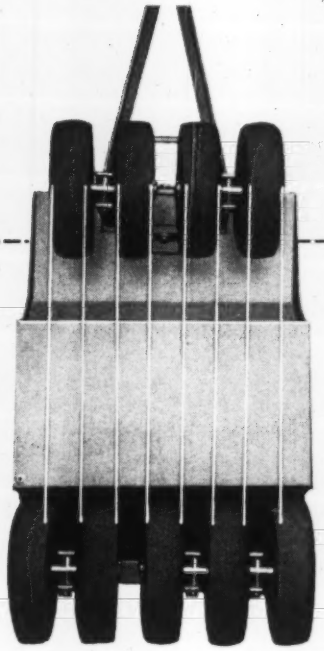
622 DIVERSEY PARKWAY — **CHICAGO 14, ILLINOIS**

Flush Kleen, Scru-Peller, Plunger. Horizontal and Vertical Non-Clogs Water Seal Pumping Units, Samplers.



Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Comminutors.

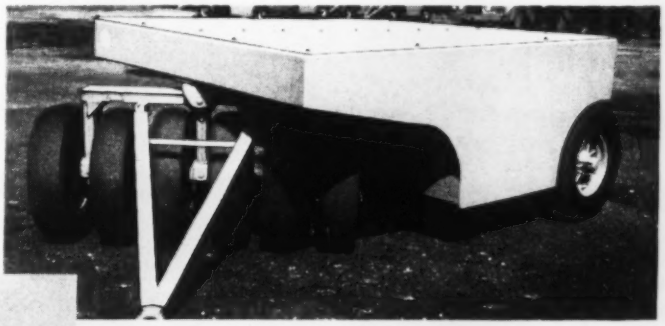
What's New in Compaction Equipment?



NEW DEVELOPMENT BY BROS... EXTRA-WIDE TIRES NOW GIVE COMPLETE COVERAGE

Bros scoops the roller field! No more lines, ridges or marks when you work with new Bros Pneumatic Tire Rollers! New Bros wide-face tires give full compaction coverage in *one pass*. And you pay nothing extra — these new super-tires are now standard equipment on all three models, in both Straight-Wheel and Wobble-Wheel* designs. For any job from rough base compaction to seal coat rolling, you'll find a new Bros Roller does it faster and cheaper.

*Patented and copyrighted by Wm. Bros Boiler & Mfg. Co.



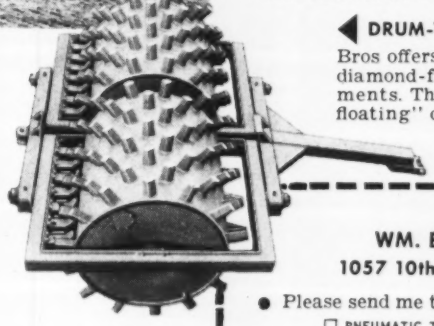
THREE MODELS — TWO DESIGNS

Choose a 7, 9 or 13 ton maximum capacity model, and then vary working weights to suit your job. Bros Straight-Wheel design has wheels moving up and down on oscillating axles. Exclusive Wobble-Wheel* design adds a weaving, kneading motion to each wheel. Only Bros offers both.

GIANT "SUPER LOAD" ROLL-O-PACTORS*

These Bros "big boys" were featured recently in an *Engineering News-Record* article describing proved advances in compaction equipment. Roll-O-Pactors* have been more widely approved on the big jobs than any other compactor. 35 and 50-ton models available — working weights from 20,000 to 100,000 lbs. Rubber is the trend in compaction — and Bros is *first* in tried and true equipment.

*ROLL-O-PACTOR patents: U.S.: 2,610,557; Canada: 487,945; Mexico: 52,368



DRUM-TYPE TAMPERS

Bros offers a complete line of sheepfoot and diamond-foot tampers for special requirements. They're really rugged! New "full-floating" design eliminates strains, permits individual drum oscillation and makes handling easier.

If compaction work is in your next job, it will pay you to find out what a difference Bros equipment can make in your time schedule and your profit figures. See your nearest distributor and mail the coupon for new literature.

WM. BROS BOILER & MFG. CO.

Road Machinery Division

MINNEAPOLIS 14, MINNESOTA

World's Largest Manufacturer of Pneumatic Tire Rollers

Road Machinery Division

WM. BROS BOILER & MFG. CO.

1057 10th Ave. S.E., Minneapolis 14, Minn.

● Please send me the new literature I have checked:

☐ PNEUMATIC TIRE ROLLERS ☐ GIANT ROLL-O-PACTORS ☐ TAMPING ROLLERS

Name_____

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Address_____

City_____ State_____

For Better Water Service at Lower Cost

In 1948, a 500,000-gal. Horton radial-cone bottom elevated tank was installed in the municipal water system at Mattoon, Illinois. The tank was erected to help the growing city unify its water system and to help meet new industrial and domestic needs.

Operation of the tank is so successful that it prompted the following statement from R. D. Wilson of Wilson & Anderson who were consulting engineers on the job, "*This elevated storage unit has contributed very greatly to the improvement of water pressure conditions of Mattoon, as anticipated, especially in the business and industrial section. We think it is a very good job and believe that all of the city officials will agree with us.*" Satisfaction such as this is the rule wherever a Horton elevated tank is installed.

If you are making plans for a water system carrying a heavy load that causes low distribution pressures and allows an insufficient reserve of water for peak load periods and fire protection, elevated storage may be the most economical answer to your problem. Horton elevated tanks with ellipsoidal bottoms are built in standard capacities from 15,000 to 500,000 gallons and with radial-cone bottoms from 500,000 to 3,000,000 gallons.

Write our nearest office today for estimates or quotations on a tank to meet your needs. State capacity desired, location and height to bottom. Quotations include complete Field Welding Supervision Service during construction without extra cost.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3.....2167 Healey Bldg.
Birmingham 1.....1596 N. Fiftieth St.
Boston 10.....1009—201 Devonshire St.
Chicago 4.....2199 McCormick Bldg.
Cleveland 15.....2263 Midland Bldg.
Detroit 26.....1541 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston 2.....2128 C & I Life Bldg.
Los Angeles 17.1556 General Petroleum Bldg.
New York 6.....3395—165 Broadway Bldg.
Philadelphia 3..1652—1700 Walnut St. Bldg.
Pittsburgh 19.....3210 Alcoa Bldg.
San Francisco 4.....1584—200 Bush St.
Seattle 1.....1309 Henry Bldg.
Tulsa 3.....1647 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

You Can Dig Anywhere Crawler Tractors Go with HYSTAWAY...

and travel at tractor speed. This means more jobs done, faster, with less equipment.

Only HYSTAWAY has *true* crawler tractor mobility and maneuverability because it mounts on a Caterpillar track-type tractor. Full track oscillation enables the Hystaway to travel over rough terrain without excessive damage to crawler equipment . . . eliminating the cost and necessity of having expensive standby hauling equipment on hand. Hystaway is the *only* revolving shovel with a complete track-type tractor for its undercarriage! This is the feature that makes the Hystaway the most modern excavator-crane available today.

Other important HYSTAWAY MONEY-MAKING FEATURES INCLUDE: The ability to do excavator-crane work and bulldozing with one piece of equipment; heavy duty diesel tractor engine for power; no tail swing, permitting work in close quarters; mountability on new or used Caterpillar track-type tractors.

And *only* HYSTAWAY combines these *seven* different machines in one!

1. Shovel
2. Backhoe
3. Dragline
4. Clamshell
5. Crane
6. Pile Driver

7. PLUS BULLDOZER!

Get full Hystaway details from your Caterpillar-Hyster Dealer...or write for Catalog 1235 to:

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HYSTER

THERE'S PROFIT IN HYSTER POWER

3 good reasons why

Transite Pressure Pipe reduces maintenance costs

For community water systems Johns-Manville Transite* Pressure Pipe keeps maintenance costs down to a minimum, while providing outstanding installation and performance advantages.

Transite asbestos-cement Pressure Pipe has a smooth inner surface which gives the pipe an initially high flow capacity. What's more, this capacity (C=140) can never be reduced by tuberculation, the form of internal corrosion which so often results in costly periodic cleaning.

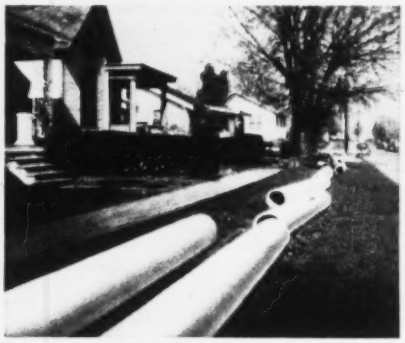
Transite Pressure Pipe is highly resistant to soil corrosion. It is entirely unaffected by electrolysis. And it reduces water losses because its factory-made, easily assembled joints stay tight in service.

Transite Pressure Pipe can save in other ways. It often permits the use of smaller pipe sizes, because systems can be designed without allowance for future flow reduction due to tuberculation. It is light in weight, easy and economical to install. And, because it maintains a full flow of water over the years, pumps can be operated at high efficiency, pumping costs held to a minimum.

For additional information, send now for your copy of Transite Pressure Pipe folder TR-78A. Write Johns-Manville, Box 60, New York 16, N. Y.

*Transite is a Johns-Manville registered trade mark.

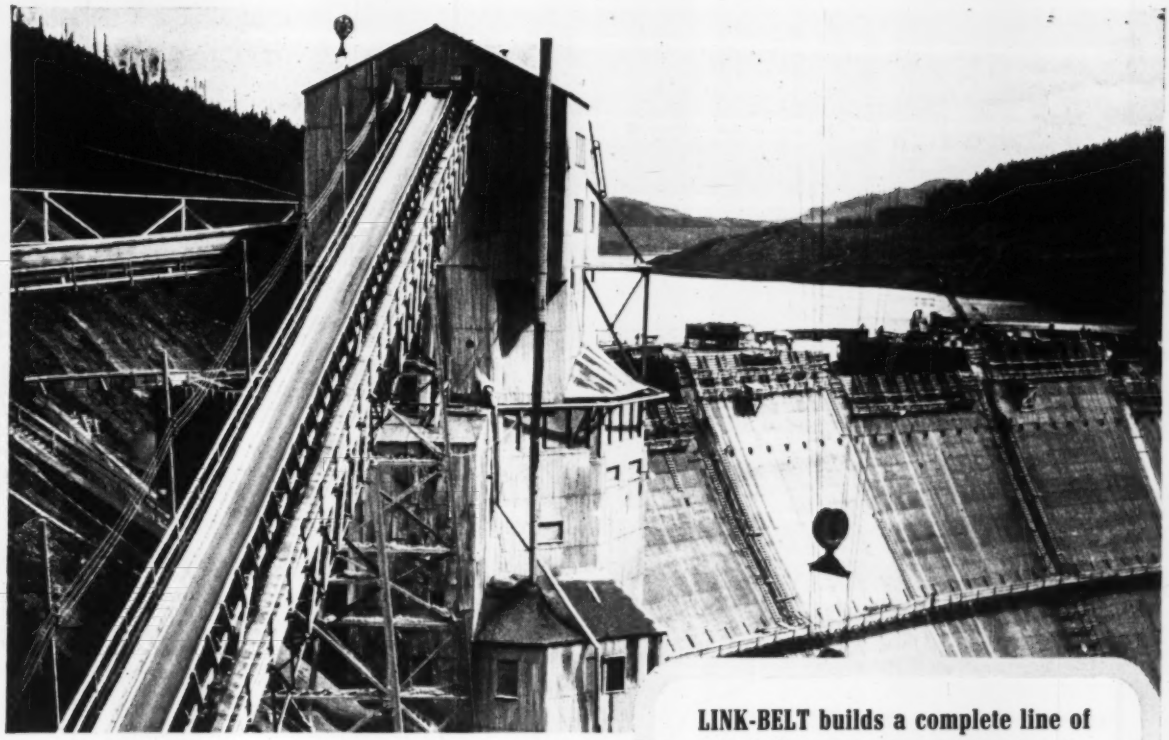
A sound investment for your community



The savings Transite Pipe has effected because of its corrosion resistance, high flow capacity and long life are being realized today by thousands of municipal water systems and Federal, state and industrial installations throughout the country.

Johns-Manville TRANSITE ASBESTOS-CEMENT PRESSURE PIPE

TOTAL ENGINEERING



1600 foot Link-Belt belt conveyor system elevated 700 TPH of blended sand and sized aggregates to concrete mixing plant at dam construction site. Plant located 383 feet above stock-pile level.

It's your assurance of top efficiency with LINK-BELT belt conveyors

HERE'S how "total engineering" works for you when you use Link-Belt Belt Conveyors. First, Link-Belt conveyor engineers analyze your needs—then recommend the *right* components. In addition, Link-Belt can supply all related equipment — other types of conveyors, feeders, elevators, car dumpers and shakers. And Link-Belt will build your supporting structures and enclosures . . . install the job completely, if desired. Call the Link-Belt office near you for any engineering assistance you need.

LINK-BELT

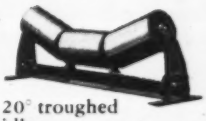
BELT CONVEYOR EQUIPMENT 13,280-G

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities.

LINK-BELT builds a complete line of belt conveyor components

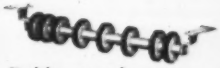
ALL TYPES OF ROLLER BEARING IDLERS

Return idler



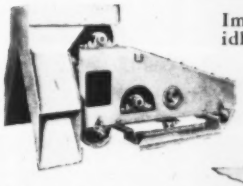
20° troughed idler

Belt-training idler



Rubber tread return idler

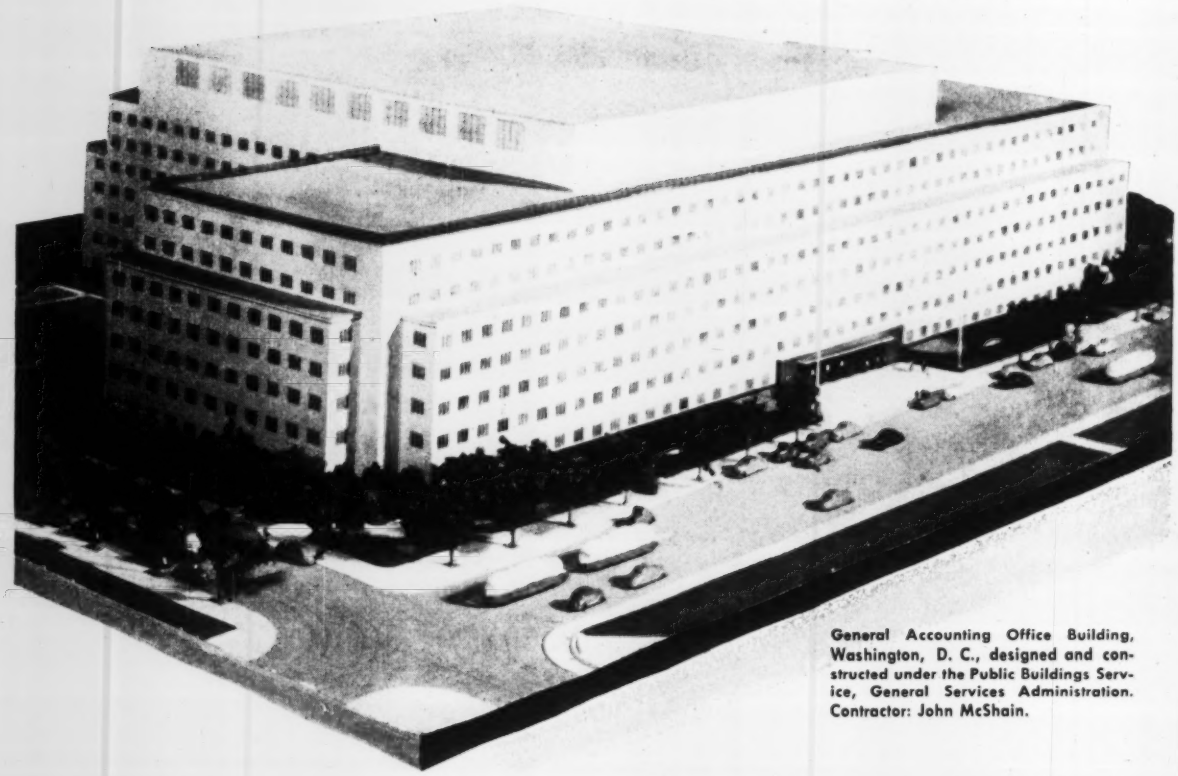
Impact-cushioning idler



BELT AND MOTOR PROPELLED TRIPPERS

COMPLETE TERMINAL MACHINERY

"...reinforced concrete was selected on the basis of economy"



General Accounting Office Building, Washington, D. C., designed and constructed under the Public Buildings Service, General Services Administration. Contractor: John McShain.

CUT YOUR STRUCTURAL COSTS with REINFORCED CONCRETE

● Because economy was such a big factor in planning this imposing new structure, every possible means of cutting costs was given careful study. As a result—*it was built of reinforced concrete!*

Engineers and builders all over the country have found that reinforced concrete *costs less!* It saves erection time, too. It is strong, durable, inherently firesafe, and highly resistant to wind, shocks, and quakes. Moreover, materials are readily available from local sources. Consider all these advantages . . . and design your next building for reinforced concrete.

CONCRETE REINFORCING STEEL INSTITUTE

38 South Dearborn Street, Chicago 3, Illinois

YOU'LL GET MORE FOR YOUR MONEY WITH REINFORCED CONCRETE

Keep up your road building reputation with American Welded Wire Fabric

IN THE STRIKE-OFF METHOD of construction being used above, flat sheets of American Welded Wire Fabric are easily laid down by two men. This is done quickly and does not delay final pouring. American Welded Wire Fabric increases the strength of concrete slabs and assures long-lasting roads.

It reduces cracking... Keeps roads smooth!

REINFORCED concrete slabs can be built with less joints if they are built with American Welded Wire Fabric reinforcement. This prefabricated reinforcement distributes loads evenly throughout the slab. And if cracks do occur, no structural damage is done to the reinforced slab. The crack cannot widen because the fabric binds the cracked portions together. If no fabric is used, concrete at or near the cracks will soon become over-stressed and break up.

You can build these advantages into your roads at low cost. The strength which American Welded Wire Fabric gives to concrete permits you to use longer slabs with *fewer joints*, insuring a smoother riding surface and less maintenance costs for joints.

Write to our nearest sales office for complete information. Ask for a free copy of the American Welded Wire Fabric Catalog.

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EVERY TYPE OF REINFORCED CONCRETE CONSTRUCTION NEEDS

U·S·S AMERICAN WELDED WIRE FABRIC

UNITED STATES STEEL

169,000 Sq. Ft. of Precast 'Incor' Concrete Wall Panels in New Grumman Aircraft Plant

● A sixth Grumman Aircraft plant is being built on a 4700-acre site, on eastern Long Island. The accent is on speed with economy, through the use of 169,000 sq. ft. of precast insulated wall panels, in a complete wall system which is fire-safe, durable, weather-resistant—2500 sq. ft. erected per 7-hour day, with one crane and crew—6 sq. ft. a minute!

Cost is less than usual masonry construction. Size and texture of units give architectural effect and appearance considered by many as superior to high quality cut-stone. Highly-mechanized casting operation gets utmost production speed by using 'INCOR'* 24-HOUR CEMENT. Panels are lifted 18 to 24 hours after casting, placed in curing room for 2 days, then stored in yard. Dependable 'Incor' high early strength assures clock-like schedules.

Another demonstration of assembly-line methods applied to construction—a potential of great significance in the light of today's building costs.

*Reg. U.S. Pat. Off.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
Peconic River Plant, Calverton, L.I.
Supervision: **DEPT. OF THE NAVY, BUREAU OF YARDS AND DOCKS**
Architects-Engineers:
OFFICE OF ALFRED EASTON POOR • SEELYE, STEVENSON, VALUE & KNECHT
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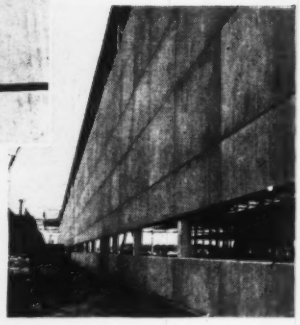
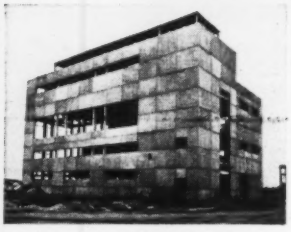
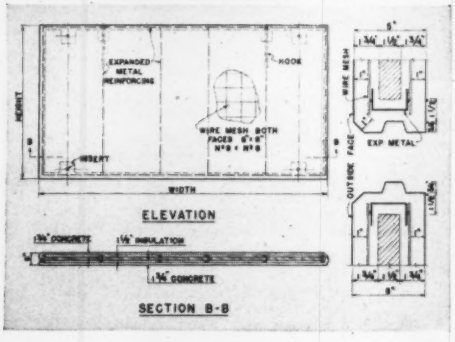
Precast Concrete Wall Panels:
PRECAST BUILDING SECTIONS, INC., New Hyde Park, L.I.
in association with: **MARIETTA CONCRETE CORPORATION**, Marietta, Ohio





Size, texture and quality of panels produces appearance considered by many as superior to high-quality cut-stone—cost is less than usual masonry construction. Above, wall of main building; left, power plant. Panel detail below.



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CIVIL ENGINEERING

AUGUST 1953

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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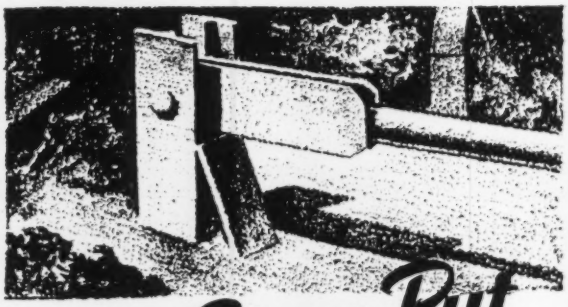
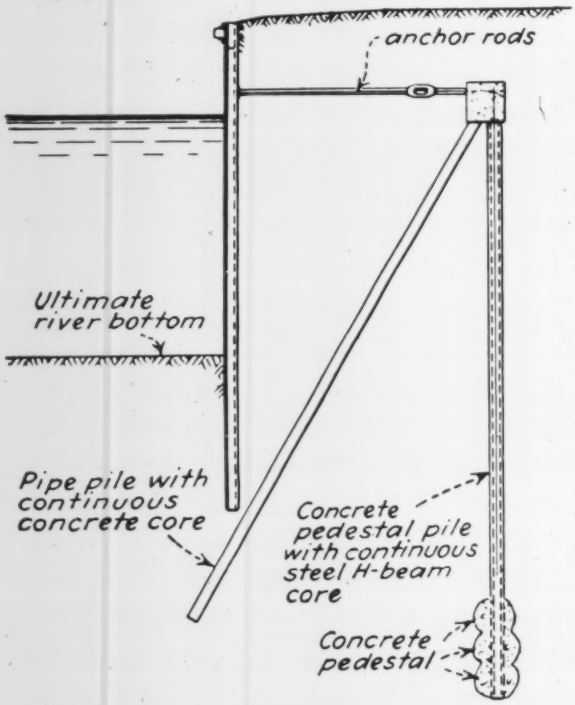


Makes Bulkheads Stay Put


anchor rods
Ultimate river bottom
Pipe pile with continuous concrete core
Concrete pedestal pile with continuous steel H-beam core
Concrete pedestal

Cross-Section of Bulkhead

WESTERN FOUNDATION CORPORATION has introduced a more effective type of bulkhead anchorage in the Cuyahoga River in Cleveland. A length of nearly 1,400 lineal ft. of bulkhead wall made up of 48 to 60 ft. steel sheet piling and projecting 7 to 9 ft. above water level, was installed along the sides of the navigable channel.

IN THIS PROJECT, sliding ground and proximity of structures made the usual buried anchorage impractical. WESTERN'S new anchorage consists of a rigid A-frame tie-back utilizing a vertical, tension-resisting Pedestal Pile* in combination with a batter pipe compression pile. In tests made under a jack lift pull of 160 tons, the Pedestal Pile showed a maximum elongation of only 0.3 ft.

DO YOU HAVE A FOUNDATION PROBLEM? Prompt consultation with a WESTERN engineer is provided in any part of the country. Write fo Catalog.

Steel pipe driven as batter pile and filled with concrete forms the front or compression leg of the A-frame while a concrete bulb pile (Pedestal Pile*) with an H-beam core forms the tension leg. The two legs are connected by a pin to which the bulkhead anchor rod is attached.

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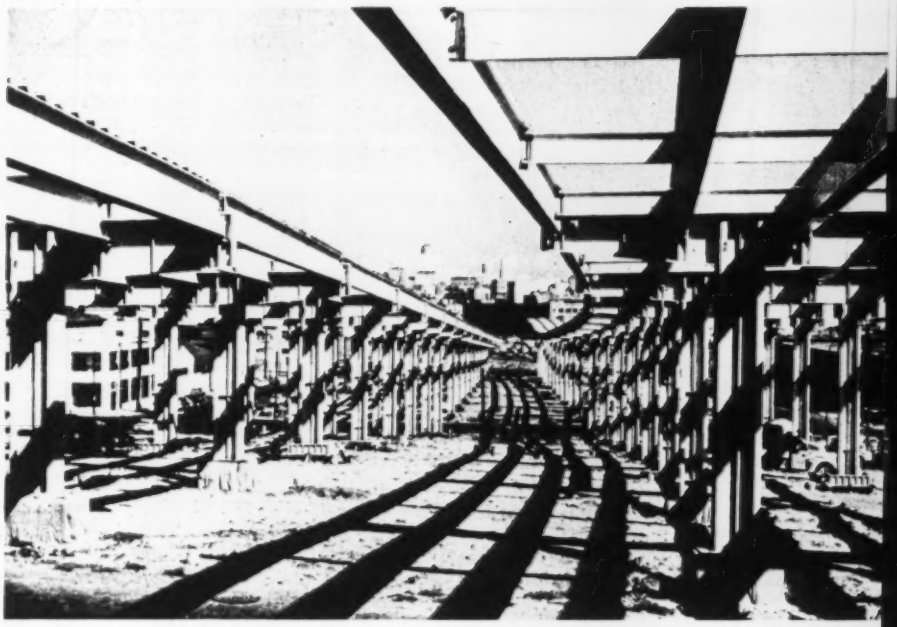
AUGUST 1953

THE MAGAZINE OF ENGINEERED CONSTRUCTION

LA MOTTE GROVER, M. ASCE

Welding Engineer, Air Reduction Co.,

New York, N.Y.



Welded viaduct structure is erected to carry Bay Shore Freeway in San Francisco. Fabrication and erection were done by Fabricated Steel Construction, Bethlehem Pacific Coast Steel Corp., Los Angeles, Calif. (See also *Civil Engineering*, September 1952, pp. 180–191, and February 1953, p. 71).

Welding research leads the way toward stronger, more economical structures

Ever since the pioneering days of welding in steel construction, a number of questions have been asked repeatedly by designers. They are questions that naturally arise in the mind of one who contemplates the use of a type of structure or method of construction not yet encountered in his own experience. If he is not familiar with welding, he asks, "How can I make sure that the welded joints will be adequate and my structure safe? Must I put special requirements in my specifications for structural steel material to assure weldability? How do welded joints and members behave under repeated stress, impact and vibration? Do residual stresses, caused by welding, reduce the strength of a welded joint or member?" Although experience during the past 25 years has provided the best answer to many such questions, it has required extensive research to answer some of them.

These questions have been prompted to some extent by difficulties encountered about 15 years ago in a few of the pioneering welded-bridge projects in Europe. Although improvements in design have been made in recently constructed European bridges, their early difficulties

seem attributable principally to the grade of steel in use at that time—a basic Bessemer steel with extensive segregations and subject to serious strain aging—very different from the structural steel now customarily furnished for bridges and buildings in the United States.

Some rolled beams of this Thomas steel (war surplus material), with butt-welded splices, were tested in France shortly after the war. They failed by brittle fracture under static loading, at a stress of only 21,300 psi. This behavior is in sharp contrast with that of similar beams tested in a current program of research in the United States at Columbia University. To fracture some welded beams of ASTM-A7 steel, it has required a combination of low temperature and very severe impact (roughly equivalent to about 70,000 to 90,000 psi static load stress)—much more severe than the impact in actual service conditions for a railway or highway bridge.

To preclude the furnishing of steel material of inferior resistance to fracture, a revised specification has been prepared by a committee of the American Welding Society, and is to be included in the Society's specifications for welded railway and highway bridges now being revised.

Many parts of the specifications and codes of the American Welding Society for bridge and building construction are based on the results of practical research and tests to destruction of large or full-scale welded specimens, which have been carried out in programs of the Welding Research Council's Structural Steel Committee, at the National Bureau of Standards and at various universities, and in programs of the Fatigue Testing Committee of the Welding Research Council at the University of Illinois. Design practices, likewise, have been built largely around these results and have become quite well standardized. They have been described in some detail by the writer in a *Manual of Design for Arc Welded Steel Structures*, and in articles on welded bridges.

There are now two active major testing programs being carried out under the direction of the Structural Steel Committee of the Welding Research Council, one at Lehigh University and the other at Columbia University. These will be described later in this article. In a smaller but important project at the Massachusetts Institute of Technology, fundamental information on elastic stability has been developed as a basis for specification requirements pertaining to details and proportions of welded members in compression. Some work has been started at the University of Florida on stress distribution in welded cover plates. In other research, extensive programs of testing of large-scale specimens and of large welded ships have been carried out to investigate the effect of residual welding stresses. Much information has been developed on their magnitude and distribution, but no direct evidence has been found to indicate that such residual stresses have been an important factor in causing fractures in ships.

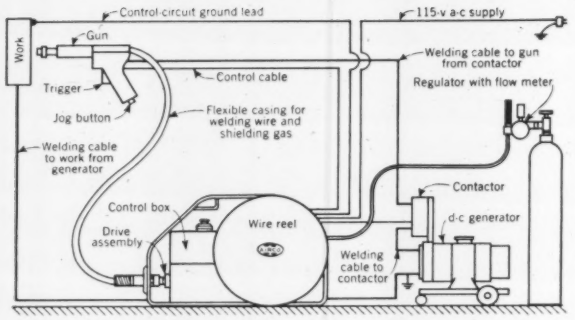
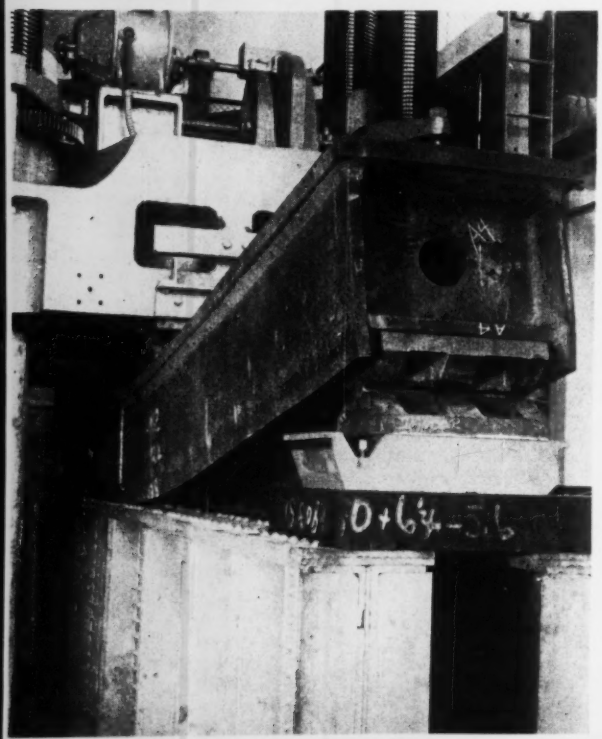


FIG. 1. Operation of semi-automatic type of inert-gas shielded metal arc-welding equipment is shown schematically. This process promises to open up new fields for structural uses of aluminum, bronzes, stainless steel, and structural steel.



Test of welded box girder is one of many tests to destruction of large welded specimens which have yielded valuable data used in preparing specifications and codes of American Welding Society for bridge and building construction. This test at National Bureau of Standards was for Structural Steel Committee of Welding Research Council.

Structural Welding Processes

Metal arc welding is used almost exclusively for structural work, by far the greater part being done by the manual process. In truss fabrication, the comparatively short runs of welding are not well suited to the fully automatic process.

Although aluminum for building construction has been restricted largely to ornamental uses and details such as window frames and sash, the Navy Department is now making extensive structural use of the 61ST-6 alloy of aluminum to reduce weight in making alterations in warships. A comparatively new semi-automatic welding process is employed, known as the inert-gas shielded metal arc welding process (Fig. 1), using a continuously fed, consumable wire electrode. The development of this process, together with developments now in progress for new high-strength weldable alloys of aluminum, promises to open up

(Vol. p. 518)

new fields for structural uses of aluminum, because of the higher welded joint efficiencies attainable. This process, in both the semi-automatic and fully automatic forms, is used for joining other metals, such as bronzes and stainless steel. It is coming into use also for some applications in the welding of mild and structural grades of steel.

Experience Forms Background for Design

The last 25 years of experience now provides an excellent background for the use of structural welding for railway bridges, highway bridges and buildings. A good deal of this valuable experience was developed during the war in the tremendous shipbuilding program, where many of the same fundamental problems were encountered.

Outstanding programs of welded bridge construction, such as those in Kansas and Connecticut and in the Province of Quebec, Canada, have provided especially valuable proving grounds, with their excellent records of service performance over periods up to 16 years, through winter temperatures of −30 deg F, in Canada. The State of California has now embarked upon a most noteworthy program of welded bridge construction for the new Bay Shore Freeway in San Francisco.

In welded building construction, much credit is due Gilbert D. Fish, M. ASCE, who has constantly contributed to the advancement of structural welding since the early pioneering days. The most recent outstanding activity in this field has been in Texas. Here there has been a fortunate combination of progressive structural engineers, such as Boyd S. Meyer, M. ASCE, cooperating with fabricators and erectors, experienced in welded construction, such as the Mosher Steel Co. of Houston, and the Bethlehem shipyard at Beaumont. The result has been a rapid advancement and improvement in design economy, especially for large welded rigid-frame office buildings.

Impact Tests of Welded Beams

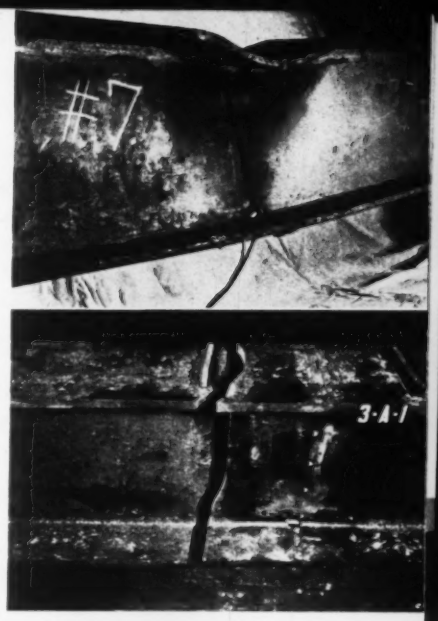
To determine the best design details and procedure for making a welded splice in a beam or girder, a project of the Welding Research Council was started at Columbia University several years ago, under the direction of Prof. W. J. Krefeld, M. ASCE, head of the Civil Engineering Research Laboratories, assisted until recently by Dr. E. C. Ingalls, A. M. ASCE. Particularly attractive cost savings had been found for welding in girder construction, but at that time there was a question in the minds of some designers as to whether residual stresses set up by welding might not combine with load stresses and reduce the strength of a welded girder, particularly under suddenly applied loads.

Wide-flange beams, 16WF 71, of 12-ft span length, with butt-welded splices at mid span, were first tested at room temperature under a load at mid span. Following static control tests, impact tests were made by dropping a heavy tup on the beam, using a rig somewhat like a pile driver. Residual stresses of considerable magnitude were measured on one beam specimen by the destructive method of relaxation, involving the trepanning of plugs upon which SR-4 electric strain gages had been mounted.

In drop-hammer impact tests at room temperature, the residual welding stresses, together with rolling-mill residual stresses and stress concentrations at the point of load application, simply lowered the apparent proportional limit. There was no evidence of adverse effect on the carrying capacity of the beams. They all failed by lateral buckling or web crippling.

The program was then redirected toward a study of behavior under impact at low temperatures, and an investigation of transition from the ductile buckling type of failure to failure by brittle fracture. Any ordinary structural steel becomes increasingly brittle as its temperature decreases. Beams of two grades of steel material have been tested, both conforming to ASTM-A7. One grade was of semi-killed steel as normally supplied. The other carried a further provision requiring it to be silicon-aluminum fully-killed steel. This steel should not be confused with Structural Silicon Steel ASTM-A94, a higher carbon steel not recommended for welded construction.

The testing conditions for these beams have been much more severe than service conditions for a railway or highway bridge. Some of the testing temperatures were of the order of −120 deg F. Such exaggerated conditions are sometimes necessary to provide complete data on trends in behavior, and to establish correlation between tests of full-size structural members of this kind and tests of small specimens of the same material. Many tests were made at temperatures to be expected for outdoor structures in cold climates, but the severity of the impact and strain rates produced was still exaggerated, to produce actual fractures. However, under static loading no fractures could be produced, even at −100 deg F.

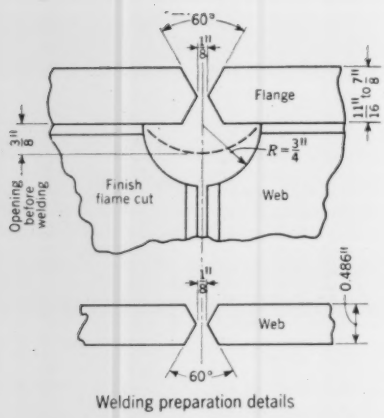


Drop-hammer impact tests on a number of butt-welded wide-flange beams have been conducted at Columbia University, New York. At room temperatures, all beams failed by lateral buckling or web crippling (upper view). Failure by brittle fracture (lower view) was produced at very low temperatures—from −5 to −120 deg F. Under static loading no fractures could be produced, even at −100 deg F.

The criterion established for evaluating the results of the impact tests of these beams was the transition temperature (of testing) when type of failure changed from buckling and crippling to failure by fracture. Beams of both types of steel were tested in several conditions, including: (1) as welded, (2) welded and subsequently given a so-called "stress-relief" or post heating, and (3) welded with preheat to reduce the rate of cooling after welding.

In some of the later tests the increased notch-toughness derived from the use of electrodes with low hydrogen content in their coatings, such as Class E-6016 and E-7016, is being investigated. Reports from practical experience as well as research, indicate a very substantial benefit from their use. From tests made thus far, transition temperatures from buckling failure to fracture failure have been fairly well defined, for beams butt welded with ordinary types of mild-steel electrodes, Class E-6011 and E-6020, as listed below:

Beam Condition	Fully Killed Steel	Semi-Killed Steel
As welded	−29 deg F	− 5 deg F
Welded stress relieved	−45 deg F	− 5 deg F
Welded with preheat	−57 deg F	−17 deg F



Welding preparation details

FIG. 2. Semicircular holes in webs of test beams facilitate making sound flange welds. Holes are left open because of difficulty in filling them with sound metal. Further tests have shown substantial improvement under severe impact and low temperature when coped holes are omitted.

It will be noted that preheating was found to be more beneficial than a stress relief carried out at some time subsequent to cooling after welding. Fortunately such preheating is a much more practical operation than the so-called furnace "stress relieving," when the preheating is of a reasonable temperature such as 150 deg F or less. In view of the severe impact and high strain rates involved in these tests, it is believed that for even the semi-killed steel, welded beams of this kind could be expected to behave in a satisfactory manner at low winter temperatures. For built-up girders with very thick flanges, the specifications should require a fully killed steel.

Effect of Coped Holes in Web

Semicircular holes have been coped by flame cutting in the webs of all the welded test beams (Fig. 2) to provide access for making the butt welds in the flanges. These small holes are left open because of the difficulty of closing or filling them without leaving defects. It has been felt that the stress-raising effect of the hole in the web would not be very serious as compared with holes or defects in extreme fibers such as flanges. Tests have been made of unwelded beams with such coped holes made by flame cutting. Other unwelded test beams have had such holes made by drilling, followed by careful filing to a smooth surface, after which a sharp notch has been filed and pressed at the top edge of the lower hole in such a way as to avoid cold working. Fully killed steel beams of both these types seem to have about the same transition temperature (from buckling failure to failure by brittle fracture) as the as-welded fully killed beams, namely −30 deg F. Further tests are being made of beams with welded splices that have been made by a special, more elaborate procedure that affords sound flange welds without the provision of web copes.

Plastic Analysis in Design

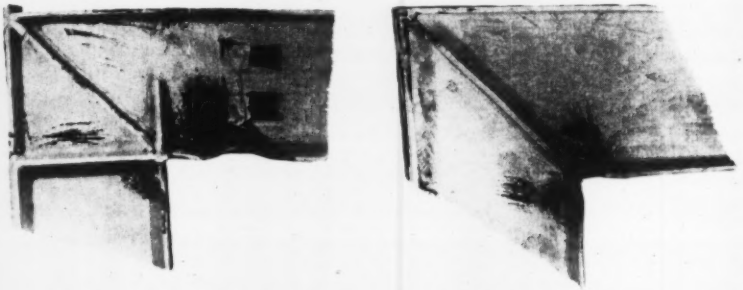
The advantages of welding in developing highly efficient and economical connections in continuous or rigid-frame construction are especially great. Consequently, as welding has come into more extensive use for building construction, a great deal of interest has been shown by designers and researchers in the method of plastic analysis of continuous frames and their components. This method has been called by various names such as "load-limit design," "plastic design" and "load-factor design." The objective of this method is to apply a suitable safety factor to the true ultimate load a structure will carry without excessive deformations or deflections, and to produce a design that is as nearly balanced as practical among the component members and connections of a continuous frame. In this way it is possible to attain maximum economy of material and construction costs.

Conventional methods of analysis, based solely on elastic behavior, usually presume that failure is imminent when a yield-point stress is developed at any point in a frame. A critical review of experience in practical engineering structures shows that this is far from true in most rigid-frame structures, and that continuous frames possess a great deal of unrecognized reserve strength.

This general idea is not new. The concept of "plastic hinges," which cause a favorable redistribution of moments and stresses, was introduced at least 25 years ago in Germany, and has been discussed extensively in the technical press in Belgium, France, and England. For many years in this country, the reserve strength accompanying continuity has been recognized to some extent by allowing increased working stresses for combined gravity loads and lateral forces such as wind forces. Further, in any practical engineering structure, very sizable plastic deformations must actually occur, as the members and connections (whether welded or riveted) become adjusted while initial loads are being received.

Interest in this method has been revived during recent years largely by studies started under the direction of Prof. J. F. Baker, A. M. ASCE, of Cambridge University. These studies showed that in some special cases the actual failure load of a continuous frame may be eight or ten times that computed by conventional analysis. Also, in many cases of continuous framing, very attractive cost savings can be realized by extending the design analysis to take into account the reserve of strength in the plastic range. Localized abrupt stress peaks, such as those indicated by elastic analysis at points of negative moment over supports, are not as significant as might be supposed. Even in columns with rigid connections of beams, there is often a great reserve of strength after yield-point stress has occurred.

To be conservative the method of analysis may be devised in such a way that under the assumed working loads



Tests of welded rigid-frame knees showed that rectangular knees with parallel flanges (left) can be proportioned easily and economically to develop capacities for moment and joint rotation considerably greater than required to meet design predictions. All sections tested failed by local instability rather than by fracture. Type A knee (right) showed less rotation capacity.

for a structure, the computed peak stresses would not exceed the yield-point stress. However, the true ultimate load capacity would be calculated, as limited by excessive deformations or deflections, recognizing the reserve strength after plastic yielding has begun. Thus, in effect, increased working stresses would result when a given factor of safety is applied.

The opportunity to develop a complete rational method of plastic analysis has been enhanced in this country by the provisions that have been made for full-scale tests to determine the basic behavior of beams, columns, welded joints, rigid knees, and complete frames in both the elastic and plastic ranges. Most of this research has been carried out at Lehigh University under the direction of Prof. Bruce Johnston, M. ASCE (now at the University of Michigan), and Prof. Lynn S. Beedle, A. M. ASCE (at present in charge of this work). The program is under the general direction of an advisory subcommittee of the Structural Steel Committee of the Welding Research Council.

In a paper presented at the 1952 Annual Meeting of the American Institute of Steel Construction, Professor Beedle cites a normal case in which plastic design of continuous framing shows a saving of 20 percent in material as compared with a conventional design for continuity by the elastic theory. It provides a 40-percent saving as compared with a design for simply supported conditions. The plastic design provides the same actual load capacity as the conventional design for simple supports. However, the conventional design for continuity has a considerably greater actual load capacity, that is, a reserve of strength not recognized in conventional design.

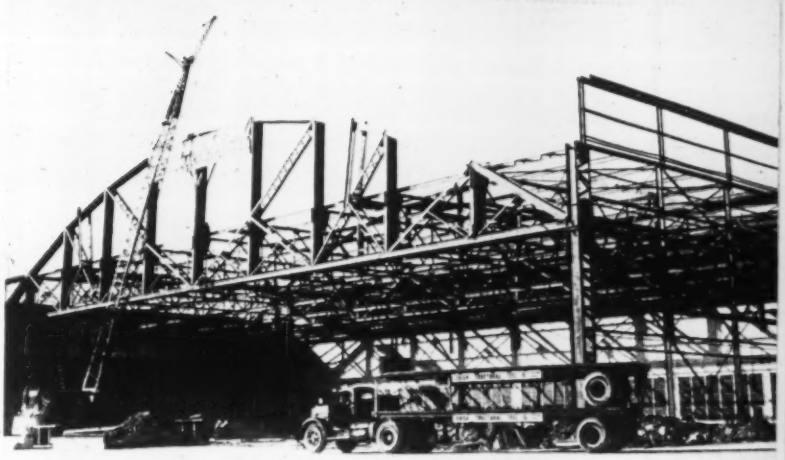
Sometimes only the stresses and joint rotations caused by bending need be considered. There are, however, cases in which other limiting factors must be taken into account. The rotation capacity of each section must be evaluated, to determine that all the so-called plastic hinges assumed in design can actually be developed before local buckling, excessive deflection or fracture occurs. There are other limitations similar to those that must be investigated in design by the elastic theory. The effect of shear deformations may be important. An analysis of the case cited by Professor Beedle showed the maximum deflection of the beam designed by plastic analysis to be less than that of a beam designed for a simply supported condition. However, deflections might be a limiting factor under some circumstances.

Tests of rigid-frame knees showed that rectangular knees with parallel flanges can be proportioned easily and economically to develop capacities for moment and joint rotation considerably in excess of those required to meet the design predictions. Knees with curved haunches showed excellent strength when proportioned according to procedures recommended by the AISC. All the sections tested eventually failed by local and lateral instability rather than by fracture. The larger sections collapsed more suddenly. It would appear that if haunched knees were used in plastic design, they should be proportioned strong enough to cause the plastic hinges to develop in the adjacent members.

The simple Type A connection, of lowest fabrication cost, showed less rotation capacity in the plastic range than rectangular knees with more stiffening. Type A collapsed more suddenly after reaching maximum load capacity. However, the Type A connection appears to behave very well within the elastic range and might possibly be used for some cases in plastic design where only limited rotation capacity is needed.

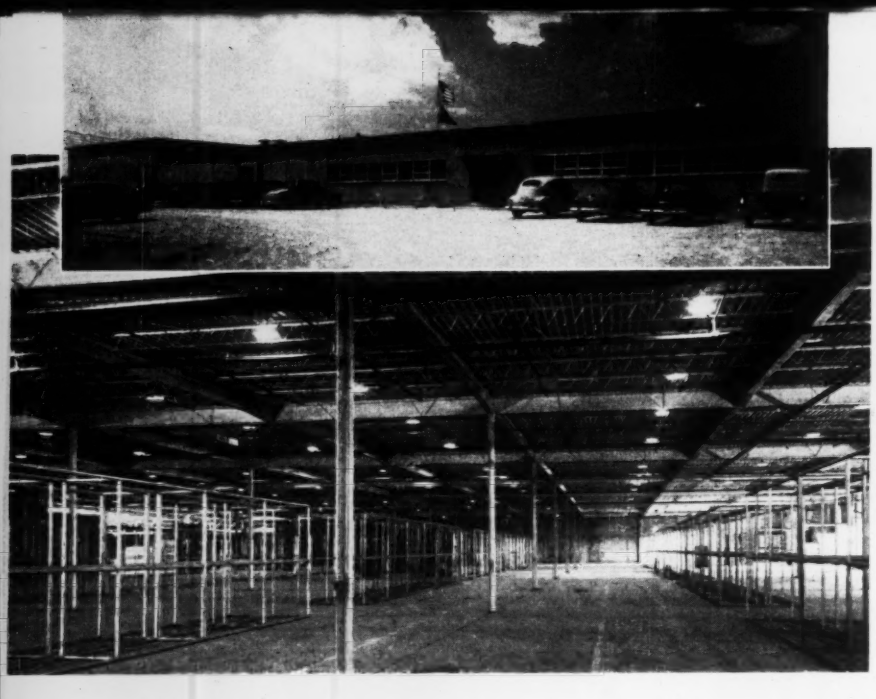
The tests demonstrated the importance of adequate lateral support for any rigid-frame knee, for example at the mid point of the knee as well as at splices between built-up haunches and adjacent beam sections.

(*Continued on page 95*)



Among heaviest building trusses ever fabricated entirely by welding are 105-ton camelback roof trusses of 255-ft span incorporated in Fairchild Aircraft hangar extension in Hagerstown, Md. Saving in steel realized by welding was 15 percent on these trusses, fabricated by Lehigh Structural Steel Co.

For building in Dallas, Tex., this 46 1/2-ton truss was fabricated by Shipbuilding Division of Bethlehem Steel Co. at plant in Beaumont, Tex.



All-welded steel design of warehouse saved owners about $22,000 in construction cost. Economies realized from careful design resulted in cost of $3.58 per sq ft. Fully continuous design resulted in use of 18WF50 girders and 14WF30 beams. Simply supported beams and girders would have necessitated 21WF73 girders and 18WF50 beams.

DAVID R. GRAHAM, M. ASCE

David R. Graham & Associates

Consulting Engineers

Tulsa, Okla.

Savings on welded warehouse begin on designer's desk

Savings in a welded structure begin with the design, as full structural continuity can only be achieved with welded connections. Such continuity, when incorporated in the engineering design, brings about a substantial conservation of steel.

Little if any material or labor is wasted when a completely equipped warehouse is constructed at a cost of $3.58 per sq ft. In the planning, advantage must be taken of every possible saving. In the case of the Hale-Halsell Grocery Co. warehouse in Tulsa, Okla., the greatest single item was the conservation of structural steel through the use of electric welded connections.

The warehouse process plan of the Hale-Halsell Co. fitted best in a building with 40 × 40-ft column spacing. With this as a start, tentative plans were worked out for truss and for beam-and-girder construction. Cost estimates indicated that the latter would be far more economical. In general, girders run over the columns at 40-ft intervals, and beams frame into the girders on the column centerlines and midway between (Fig. 1). Bar joists span between the beams and are covered with a steel deck.

Completely Welded Design Chosen

The decision to weld all connections of beams and girders, making the members fully continuous through all points of support, was based on a comparative study (Fig. 2). The unit weight of the structure, using each system with the same arrangement and the same design loads, was computed as follows:

	Design Load, psf	Spacing, ft	Unit Weight of Structure, psf
Simple structure:			
Girder	73	40	1.83
Beam	50	20	2.50
			4.33
Continuous structure:			
Girder	50	40	1.25
Beam	30	20	1.50
			2.75

The total weight saved by using the continuous structure thus is:

$$4.33 - 2.75 = 1.68 \text{ psf}$$

At 15 cents per lb of steel in the 87,000-sq ft building, this represents a direct saving of

$$87{,}000 \times 0.15 \times 1.68 = \$21{,}924,$$

or about 6.6 percent in the total cost.

Such comparative cost studies were made in planning all parts of the building and its equipment. Only in this way, the associated engineers feel, could a unit cost as low as $3.58 per sq ft have been achieved.

For the beams, a 14WF30 member was selected to meet the positive moment requirement. Resistance to meet the greater negative moments at supports was provided by splitting and widening near these points. The end spans were cover-plated a short distance near the center to provide for the positive moment of 60,000 ft-lb.

As positive and negative moments in the girders were of similar magnitude, an 18WF50 member was found to meet the conditions at supports and at center of span. A study of the diagrams will show that to meet the conditions with a simple-span design incorporating riveted or bolted connections would have required girders of at least 21WF73 section and beams of 18WF50. It is evident that the use of a continuous structure instead of a simply supported structure made possible the reduction in steel tonnage.

Walls are of tilt-up construction. Each panel was cast on the floor of the building, directly adjacent to its position in the wall, using curing compound to prevent adherence. The finished panels were lifted into place by a special rig fastened to the panel by bolts. The panels were rotated about their bases with little difficulty, and were set in mortar to make a waterproof joint at the bottom.

The panels were placed with a 24-in. space at column locations, and columns were poured later. Dowels were left extending from foundation and wall panels for fastening. For waterproofing, asphalt mastic was placed in a recess in the joint before the column was poured.

The air conditioning equipment, electrical, mechanical and sprinkler systems were completely designed and detailed on the engineering plans to assure uniform bidding as well as proper operation. The sprinkler system, for example, was furnished for $19,800 under competitive bidding. This is $0.23 per sq ft. Such installations have cost several times this amount when purchased on a negotiated basis for other warehouses belonging to the same company.

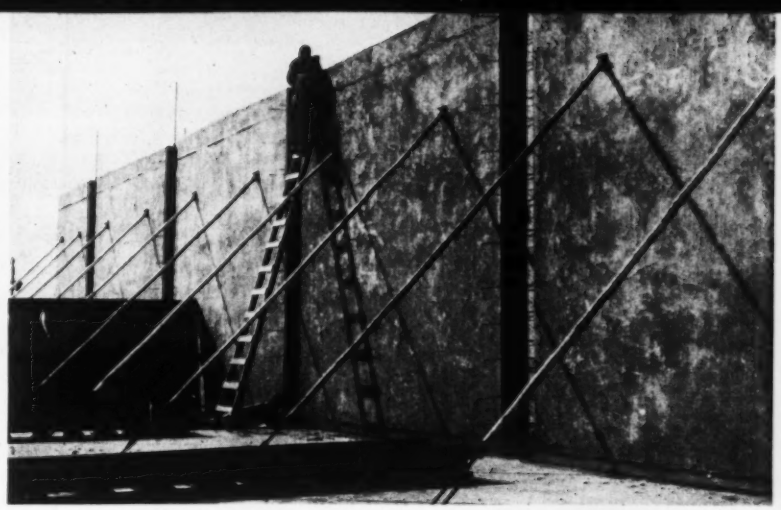
Labor Rates Not Determining Factor

Engineers are frequently requested to furnish information on prevailing rates for on-the-job trade labor to aid in predicting building costs in various parts of the country. Nothing could be more useless, as such variations are small compared with the cost of materials and equipment and the great variations which are directly controlled by the planning and detail design.

Wages of on-the-job labor are popularly blamed for current building costs. The actual cost of construction is far more dependent upon material costs and the complications due to modern equipment not provided for initially in construction a few years ago but now considered a functional necessity. A look at the labor totals for several trades on the Hale-Halsell building bears this out:

Trade	Total Labor Cost	% of Total Cost of Building
Steel erectors	$5,110.00	1.64
Electric workers	5,040.00	1.61
Plumber labor	5,270.00	1.68
Carpenters	5,500.00	1.77

The building was planned and its construction managed by David R. Graham & Associates of Tulsa, Okla. The principal contractor was the Tulsa Rig, Reel & Manufacturing Co.



Tilt-up walls are temporarily supported before column sections are poured. Steel will rest directly on poured column.

General Description of Warehouse Building

Dimensions:

Size	250 × 350 ft
Clear height inside	16 ft
Total space	87,000 sq ft
Office space	4,250 sq ft
Cold storage space	800 sq ft
Car spots	6

Structural Features:

Warehouse space, freight-car height
Frame, welded steel
Roof, metal deck with felt insulation
Walls, tilt-up concrete

Utilities:

Air conditioning in offices
Sprinkler system in entire building
Refrigeration in fruit storage area
Lighting: Office, fluorescent
Other, incandescent
Pneumatic-tube system between general and warehouse offices
Intercommunication system between general and warehouse offices
Overall cost $312,470.51

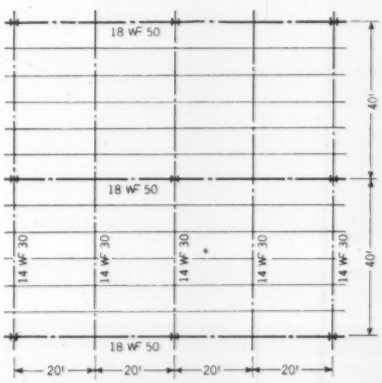


FIG. 1. Simple framing plan provides complete continuity for all beams and girders. Structure is 350 ft by 250 ft overall.

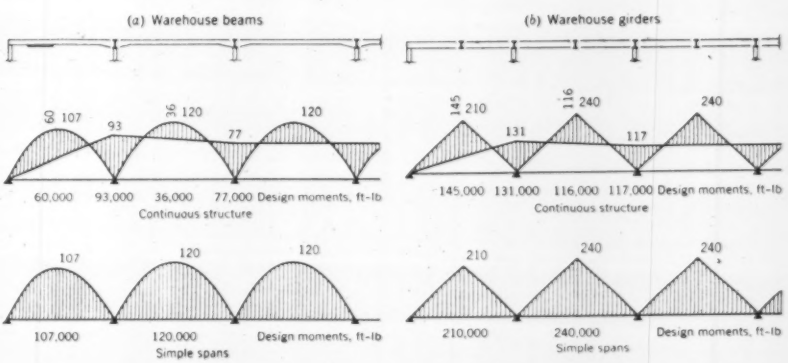

(a) Warehouse beams
(b) Warehouse girders
60 107 93 36 120 77 120
145 210 131 116 240 117 240
60,000 93,000 36,000 77,000 Design moments, ft-lb
Continuous structure
145,000 131,000 116,000 117,000 Design moments, ft-lb
Continuous structure
107 120 120
210 240 240
107,000 120,000 Design moments, ft-lb
Simple spans
210,000 240,000 Design moments, ft-lb
Simple spans

FIG. 2. Bending moment curves for beams (a) and girders (b) are compared for simple spans and continuous design. Structural advantage obviously lies with continuous design.

How to plan and pay for the safe and

LACEY V. MURROW, M. ASCE

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In any consideration of the problem of "How to Plan and Pay for the Safe and Adequate Highways We Need," it is necessary to set forth and recognize certain basic and known facts; and to be fully aware of those aspects that are not now known. The situation can be likened to a highly involved mathematical equation in which many factors are known, but which at the same time contains so many unknown factors that the equation cannot be quickly and easily solved.

Land, sea, and air transportation are the arteries that carry the life blood of the nation. This is true because, in our involved economy, all commodities and manufactured products in quantities above the requirements of local consumption, are of little or no value unless, or until, they are transported to points where they may be consumed and used.

The relatively great abundance of transportation in this nation has led us into some wasteful practices and the acceptance of temporary expedients to solve the ills, as they have arisen, of highway, rail, water and air transport. Each of these four means of transportation impinges one upon another, and the deficiencies of one cannot be permanently corrected without giving some consideration to the problems of the others.

The basic American principle of fair treatment for all in the matter of taxes and regulation is the assumption on which all other considerations must be based. In the past, all levels of government have, at one time or another, followed practices that promoted or favored first one and then another of the four forms of transport. It would seem that the time has now arrived when it should be possible to reestablish our basic principle of fair treatment to all. Then each form of transportation will, because of competition and proven economic laws and standards, seek its own level. Furthermore, each will then serve the needs of commerce, national defense, and the public welfare in the fields and to the extent to which it is best suited.

The known facts

Based on the above stated principles, it is now possible to examine some of the facts and known factors of the problem at hand in planning and financing an adequate highway system for the nation. The following statements are true and factual, supported by the available public record:

1. For more than thirty years, the Bureau of Public Roads has handled technical, administrative, and fiscal relationships with the 48 states and with foreign governments, in a manner not exceeded in its excellence by any other agency of the federal government. With great benefit to all, the pattern thus established could have been followed by other federal agencies in their dealings with state and local governments.

2. The highway departments of the various states are now staffed with highly trained engineers and technicians, fully qualified to plan, design, and build the most modern highways. The overwhelming majority of these men display a devotion to duty and a sincerity of purpose more normally to be expected and found in the priesthood and the ministry.

3. Cities and counties have consistently improved their engineering capabilities, and some of the larger cities and more populous counties retain engineering talent of the highest order.

4. The construction industry in this country today is capable, willing, and able to undertake any amount of highway and bridge construction that can be soundly financed.

5. In the absence of all-out war, the steel mills, cement plants, oil companies, and fabricators will shortly be seeking new outlets for their present high-production capacity.

6. Money, available and seeking sound investment opportunities, was never more plentiful. Insurance companies, and the pension or retirement funds of large corporations, are new and potential sources from which economically sound toll bridges and highways might be financed.

7. There has recently grown up in this country a considerable number of consulting firms with much background and experience in highway engineering, traffic surveys, and finance. This specialized knowledge and experience are available when and

adequate highways we need

In the recent General Motors Corporation competition for solutions to the problem, "How to Plan and Pay for the Safe and Adequate Highways We Need," this paper by General Murrow won second place, and the author was awarded $10,000. More than 44,000 solutions were submitted, most of the winners being from the technical field

where needed. The highly skilled and technical services of the Automotive Safety Foundation have been most beneficial in assisting various states to analyze their present highway deficiencies and to forecast future requirements.

8. The National Safety Council has done much, with limited funds, to educate the public and promote highway safety.

9. At Northwestern University the Traffic Institute has been of great assistance to many states and municipalities in the training of traffic officers.

10. It is estimated that there was expended in the calendar year 1952 for all highway and street purposes in the United States a total of $3,800,000,000. In view of the present unsatisfactory condition of a large percentage of the 3,300,000 miles of highways and streets, it is possible to gain some idea of the tremendous problem that is here considered.

All of the foregoing statements are favorable and on the credit side of the ledger.

As to financing . . .

Present unsatisfactory highway conditions, the widespread desire for improvement, and the basic character of the American citizen, all insure that adequate funds can be raised without much difficulty, once the taxpayer is convinced that the portion of the cost he is asked to pay has been arrived at fairly, honestly, and without prejudice to other groups and interests. He is, in all justice, entitled to a current, accurate, and understandable explanation. This paper outlines one method by which this desirable end can be accomplished.

—Lacey V. Murrow

The unknown factors

Now to examine some of the questionable and unknown factors in the equation:

1. There is now and always has been a serious lack of balance in the various states in the matter of highway-user taxes or charges. Yet this is a problem that must be left strictly to each state for solution and determination. This condition probably developed from the extensive and conflicting testimony submitted to state legislatures by representatives of various transportation and allied groups. There has been a deficiency and a vast need for factual and current data on which sound legislation on this subject might be based.

Conditions have changed so rapidly that careful studies made even ten years ago are no longer valid. Older surveys and reports, though made by eminent and sincere men, are of little value as a basis for solving the problems of today.

2. Committees of the Congress and other agencies of government have held hearings on the transportation problem, and have earnestly attempted to arrive at an equitable distribution of highway costs as between the various classes of users. Because of the wealth of conflicting testimony, little of which was truly factual, the tangible results from these hearings have been disappointing.

3. The old and highly important question of maximum weight, height, length, and width of commercial vehicles remains unanswered. This situation has placed the highway engineer in an untenable position. He designs and builds to provide for certain loadings and space displacement, only to find that, by legislative enactment, the structure must carry far beyond its designed capability. The grave question of costs is also primarily involved. The engineer can design and build to adequately support any load that may be imposed; however, his funds are limited and the mileage that is his responsibility is always beyond his means. The highway administrator and engineer is likewise much concerned with the question of who should pay, and how much, for the use of facilities owned and maintained by the public.

4. Safety is another of those intangibles that is difficult to evaluate. Many generally accepted opinions on highway safety do not stand up under careful examination.

Speed is not, necessarily, the major factor in highway fatalities. Slow and careless, or incompetent driving oftentimes is more dangerous and may, indirectly, be the cause of many fatal accidents.

The mixing and intermingling of all classes of vehicles in the same channel of traffic flow is another secondary cause of accidents. This situation is receiving some study, based primarily on accident records of certain well-known parkways. The time may come when, in the interest of reducing traffic density and promoting safety, we will build separate facilities for private and commercial vehicles.

5. Safety is inseparably tied to education and enforcement. Much progress is being made in driver education and training programs, especially in the public schools and through such organizations as the American Automobile Association.

The enforcement of traffic laws, ordinances, and regulations has not

kept pace with other developments. This condition is due to public apathy and the fact that it is not popular to criticize the efforts or practices of law enforcement officers and agencies. Actually the fault lies, not with the officer, but with the system under which most traffic officers are required to work. Many states now have state police organizations, and traffic enforcement becomes a secondary responsibility. It is only natural that intelligent and ambitious men should prefer detective work or other phases of law enforcement to the trying, difficult and presently unrewarding duties of a traffic officer.

6. For more than two years there has been a growing anxiety and concern in this nation and throughout the world over the military situation in Korea. During two years of war in that country, the United States Armed Forces has suffered 110,611 casualties, of which 17,445 were killed in action and 12,506 missing. During the same two-year period automobile accidents have caused an estimated 76,000 deaths, 4,000,000 injuries and $7,000,000,000 in economic loss. In view of the reasonably accurate statistics quoted above, it is truly amazing that this nation has calmly accepted the loss of life, the injuries and economic loss that have occurred on the highways.

The recommendations

The magnitude and urgency of the matter here discussed leads to the following recommendations, set forth in what is believed to be the order of their importance:

1. Retain Bureau of Public Roads in present role

Retain the Bureau of Public Roads in its present role, guided by the same sound principles of engineering and administration that have characterized this agency during the past thirty years. As it has in the past, the Bureau must continue to be free from political interference and favoritism. It must also be provided with additional funds for research and development.

2. Make an objective analysis of the problem

It has been pointed out that basic and current data on many aspects of this problem are not now available. Likewise, the studies and proposed remedies made by both governmental and private agencies are outmoded and have failed of public acceptance. Both these deficiencies can be corrected if one or more of the illustrious philanthropic foundations can be interested in undertaking a truly complete and objective analysis of the problem. It is recommended that such a study be divided into three broad fields as follows:

(a) **Regulation.** It will be necessary to carefully analyze the past and present practices of transportation regulatory bodies, both at the federal and state level, and from these studies to draw sound conclusions concerning policies and practices that should properly guide the actions of regulatory bodies in the future. It naturally follows that inquiry will be made into rates, existing laws, and the granting of franchises or certificates of convenience and necessity. In this broad field it will also be necessary to examine and evaluate, in light of the public interest, the promotion policies and practices of the federal government with respect to various forms of transport.

(b) **Taxes.** The whole question of taxes on all forms of transport by government at various levels should be carefully analyzed in order to properly evaluate a just, fair and equitable tax or charge that should be made against the highway user. Presently imposed overlapping taxes against the highway user leave him without the information to even approximate the charges that he is paying for the facilities which he uses. In some communities gasoline is taxed four times, by municipality, county, state and federal government. One of the evils of tax overlap, beyond the obvious fact that it costs the taxpayer more money, is that it is less efficient for the various levels of government to collect their money through different channels. A considerable portion of the money is being spent in the various mechanics of collecting it. This study will also require investigation into the propriety and extent of securing additional revenue from sources other than the highway user.

(c) **Maximum Design Criteria.** It is essential that this matter be fairly and promptly determined, in order that the differential in charges by the various classes of highway users may be justly and properly assessed. For many years the authorized and responsible spokesmen for the military have stated that structures and highways of a design sufficient to properly serve the civilian economy would, also, be adequate for military requirements. This aspect of the study will necessarily require equitable findings with respect to maximum weight, length, height and width of commercial vehicles. It is essential also, in this phase, that much and careful consideration be given to the proper method of collection of highway user charges as between the various classes of vehicles.

The above cited phases of the study are only general in nature, and it is recognized that many other related subjects must be considered. Such a study as is here proposed, would necessarily inquire into toll roads and toll bridges, and the matter of reciprocity between the states. The present and recommended division of available funds between the states, counties and cities, and the extent to which the federal government should aid in financing heavy construction, plus many other issues, are the areas in which we must have current information, facts and sound recommendations.

Talent for such a project is available in the transport industry, the highway departments, and in the transportation, economics, and engineering schools of colleges and universities. Extreme care must be used in the selection of all personnel employed on this work, for the men in responsible charge must be a group whose ability, integrity, and fairness will automatically place their findings on such a high plane that the report will be accepted by the public, responsible representatives of other forms of transportation, and government at all levels.

At first glance, this proposal may appear to be tinged with Utopian ideas or merely wishful thinking; however, throughout our society and particularly in the overall transportation field, the most influential and responsible persons are men with a keen sense of fairness, sound judgment, and interest in the public welfare. Heretofore they have not had the facts on which to base decision and action. There is no way, short of temporary expedients, in which this problem can be solved quickly and inexpensively. Its magnitude alone precludes a tricky or an easy solution, and its importance to the nation cannot be overemphasized.

3. Establish regional and interregional committees

Regional and interregional committees should be established, the regions to be determined by logical geographic, traffic flow and trade interest criteria. In the absence of a better solution, the regions as established in the rules of this contest can be used.

The personnel of both regional and interregional committees should be composed of responsible representatives of the public, the Bureau of Public Roads, the state highway departments, the Department of Defense, state legislative committees, and such other interested agencies or associations as the governors of the respective states in each region may jointly agree to be appropriate. It would be the responsibility of the regional committees to be familiar with the present highway net of the region, and make recommendations to the legislative bodies of the states within the region as to the general pattern of improvements that would best serve the individual state and the region.

The interregional committees would be composed of selected persons from the adjacent regional committees, whose responsibility it would be to advise on proper integration and coordination of routes and improvements as affecting two or more regions. These committees, after proper indoctrination and experience, would prove most helpful in popularizing and advancing the desirable aims of the American Association of State Highway Officials.

Enactment of this recommendation should bring cohesion, stability, and sound judgment to bear on future planning.

4. Set up long-range construction programs

The Congress and state legislatures should be encouraged to grant as much lead time as possible in the authorization of highway expenditures. Year to year appropriations are not a sound basis for proper planning purposes.

5. Make traffic laws more uniform

Real effort should be exerted to bring about some semblance of uniformity as between the states in the licensing of drivers and in the traffic laws under which vehicles may be operated. In no other form of interstate travel is the operator of a conveyance faced with such involved and conflicting requirements. The operator of a train, a steamship or an aircraft, adheres generally to the same standards of operation and performance throughout the entire continental limits of the United States. Not so with the operator of a motor vehicle. In the same geographic area he is confronted with 48 different state traffic laws, and the varying and conflicting traffic ordinances of thousands of cities.

If some order can be brought out of this chaotic condition, it is hoped that all of us will accept the license to drive a vehicle as an earned privilege, and not as an inalienable right that should not be taken from us.

6. Ensure proper law enforcement

Proper enforcement of laws pertaining to highways and traffic will never be adequate until it is generally recognized that it is a special type or kind of law enforcement requiring highly trained and competent men. This work must be their sole duty, except in times of emergency. It seems logical that they should be an operating part or division of the state highway department.

7. Establish economic safeguards for employees of state highway departments

Safeguards must be established to protect qualified engineers, technicians, and other employees of the state highway departments in the matter of their earned promotions and continuance of employment. A few states have already protected their investments, in the experience and training of personnel, by means of state civil service legislation. The science and art of highway construction and maintenance has long since ceased to be a field in which the public can afford to employ novices or political hacks. The importance of this recommendation is emphasized by the fact that there is now a shortage of engineers, and forecasts made by the Engineers Joint Council, based on college and university registration, are not encouraging for the future.

The tremendous amount of money expended annually requires that only qualified personnel be retained. This highly specialized branch of the engineering profession must be stabilized, and afford proper compensation, so that the engineering schools of colleges and universities will again voluntarily recommend this field to their outstanding graduates.

8. Use highway construction to stabilize employment

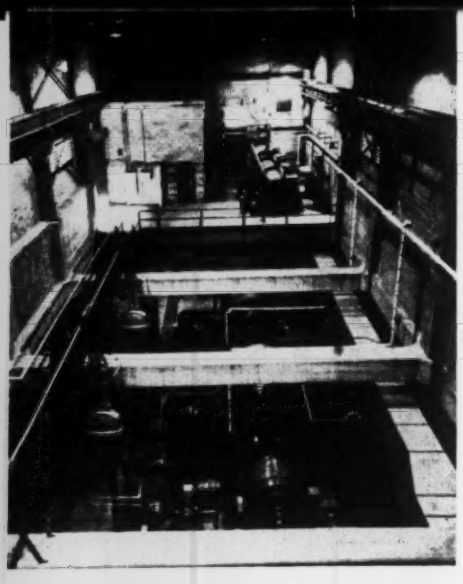
Needed highway construction offers one of the most economically sound methods of stabilizing employment and many segments of industry in times of distress. Proper advance planning is, therefore, an essential and necessary function of all highway building agencies.

In summation, the capabilities for necessary planning for the safe and adequate highways we need are now available. Qualified personnel, with the technical knowledge and experience, are willing and able. The enactment of certain state legislation would facilitate and speed this planning phase. However, the real "know-how" and basic data have been accumulating for many years and can be activated toward completed plans in a very short period of time.

It is in the field of finance that we encounter our greatest deterrents and difficulties. The colossal amount of money now being expended, the larger requirements of the future, and the complexities of our present methods of financing highway construction, all point to the necessity for more current and accurate data. It is true that there is now available a vast wealth of statistics and general information on this subject. In the main, however, it has not been fully and currently analyzed and evaluated. Also some of the agencies and individuals who have previously wrestled with this problem are, to some extent, suspect in the public mind. In some instances it would appear that they started with the answer, and thereafter labored mightily to justify the answer.

The source of the funds necessary to accomplish the work here outlined is of utmost importance. It is believed that the highly respected philanthropic foundations are the only sources of revenue that can be fully accepted as being entirely free from partisan or political considerations. It is again emphasized that there is no quick, inexpensive or short-cut solution to this problem, that will stand up over any appreciable length of time.

Present unsatisfactory highway conditions, the widespread desire for improvement, and the basic character of the American citizen, all insure that adequate funds can be raised without much difficulty, once the taxpayer is convinced that the portion of the cost he is asked to pay has been arrived at fairly, honestly and without prejudice to other groups and interests. He is, in all justice, entitled to a current, accurate and understandable explanation. This paper outlines one method by which this desirable end can be accomplished.



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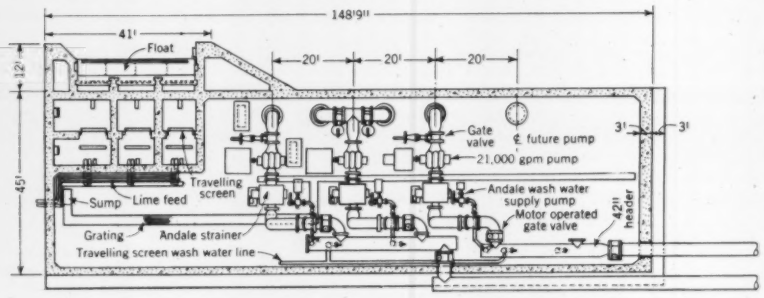
Intake structure contains three 21,000-gpm pumps, each driven by 1,250-hp motor, providing total capacity of about 90 mgd. Three traveling screens can be seen in background. Concrete struts span pumproom at El. 735 to reinforce outside walls against external water pressure. Building is designed to withstand flotation and hydrostatic pressure if river should rise to El. 743, top of concrete substructure.



CHARLES W. GRANACHER, M. ASCE, Project Engineer, Dravo Corporation, Pittsburgh, Pa.

Water intake for steel company built

In building a new river intake for Jones & Laughlin Steel Corp.'s Pittsburgh, Pa., works, it was necessary for the pumping installation to be capable of furnishing water to the steel mill even when the river was at flood stage. The Contracting Division of Dravo Corporation was awarded the contract to construct this intake, which provides water needed for quenching and other operations in connection with the steel company's $400 million expansion program, major item of which was 11 new 250-ton-capacity open-hearth furnaces.

Besides the pumping installation, Dravo's contract covered the design and construction of the structure, which is on the south bank of the Monongahela River at the foot of 34th Street, Pittsburgh. During the 1936 flood the river rose to El. 742 at the intake site. However, because of flood control dams built by the U. S. Engineers on the headwaters of both the Allegheny and Monongahela rivers the estimated future high water is El. 735. To guard against exceptional floods, Jones & Laughlin required that the river intake be designed to withstand flotation and hydrostatic pressure if the river should rise to El. 743, the top of the concrete substructure.

Since the intake is built on a sloping river bank, steel bearing piles, driven to rock, were used to support the structure. The front row of piles were battered to resist the horizontal thrust of the river bank.

The floors at Els. 698 and 715 (Figs. 1 and 2) were extended past the walls on the back side to increase the weight of the structure. Also the upstream end wall was made 1 ft thicker than the other walls for added weight. The total weight of the structure is greater than the weight of the volume of displaced water with the river at El. 743. In this computation, the uplift value given the bearing piles was their dead weight only.

As screened openings through the front walls of the wet wells at El. 715 prevent pumping out the wet wells, tunnel, and pump suction chambers when the river is above that elevation, the walls of these parts were designed to resist water pressure with the river at El. 715. The walls and floor of the main pumproom, however, were designed to resist water pressure with the river at El. 743.

The 4-ft-thick floor was designed to resist uplift on a span from wall to wall. The walls were reinforced vertically to span from the floor to a horizontal beam at El. 735 with the part above being designed as a cantilever. These horizontal beams are supported by concrete struts at the same elevation, which makes the spans of the beams along the sides of the building 21 ft long, but the beam along the upstream end of the building spans the full width. At the downsteam end of the building these beams and struts are replaced by a concrete slab at El. 735 to furnish a working platform.

That part of the intake below the bottom of the main pumproom floor was constructed in a single-skin cofferdam of steel sheetpiling. After the concrete had been poured to El. 711, the front row of cofferdam piling was blocked to this concrete, and earth berms with their tops about 6 ft above pool level were built connecting the upstream and downstream ends of the front wall of the cofferdam to the river bank. Then the cofferdam bracing was removed and the two ends and the back row of sheetpiling pulled. This method allowed the remainder of the intake to be built in the open.

The reinforced concrete substructure is 148 ft 9 in. long by 45 ft wide and extends from 16 ft below normal pool to 33 ft above pool. An intake forebay is provided which extends 12 ft riverward of the main structure. The superstructure is of concrete block construction, 22 ft high, with steel columns supporting a 15-ton traveling overhead crane and steel roof trusses. Roofing is of corrugated asbestos.

Raw river water on its way to the pumps flows under a steel box float which skims off large floating debris and through bar screens made of railroad rails into three separate wet wells (Fig. 2). In each well is a Link Belt traveling screen having 6-ft-wide baskets of copper wire screen cloth with $^3/_8$-in. square openings. In back of the traveling screens lime is added as needed to reduce the

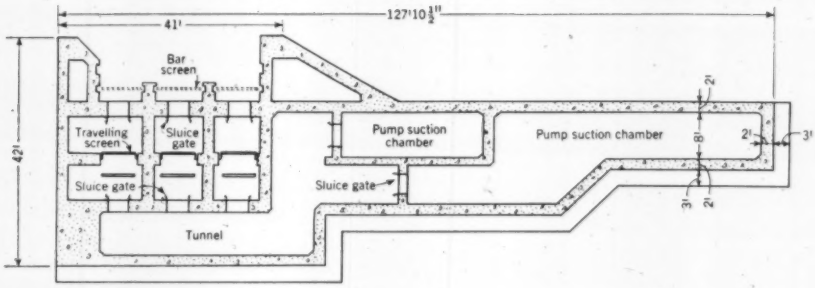


FIG. 1. Plan of pumproom floor, at El. 715, shows three pumps in present installation and space for fourth. Middle pump can take suction from either of two suction chambers so that two pumps can be kept operating if one chamber is shut off for cleaning or pump repair.

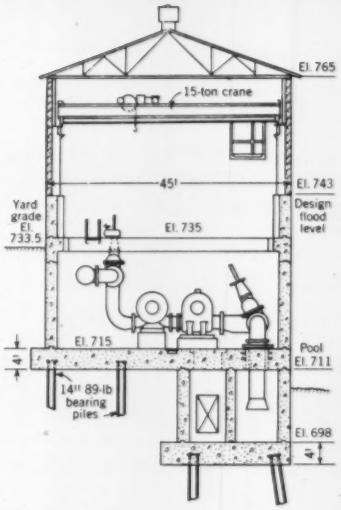


FIG. 3. Section through pumproom.

Above:

FIG. 2. Plan of intake building at El. 698 indicates pump suction chambers and sluice-gate locations. Structure rests on steel bearing piles driven to rock. Floor at this elevation, and pumproom floor at El. 715, are extended past back wall to increase weight of structure.

to withstand Monongahela River floods

acidity of the water to a tolerable level. At the front and rear of each wet well is a motor-operated sluice gate, 48 in. wide by 84 in. high, which permits isolating and emptying any one of the three wells for screen repairs and cleaning. From the wet wells, the water flows through a tunnel under the main intake floor, through 48-in. by 84-in. sluice gates, into one of two pump suction chambers. From here the pumps pick up the water and start it on its way to the furnaces.

At present three pumps are installed (Figs. 1 and 3) but space has been provided for a fourth when water demands exceed the present capacity. The middle pump has a double suction line, one leg of which extends into each of the two pump suction chambers. Thus two pumps can be kept operating when one chamber is shut off for cleaning or pump repairs.

The three main pumps are DeLaval single-stage horizontal units, driven by 1,250-hp motors. They operate at 720 rpm and each will deliver 21,000 gpm (30 mgd) at a total dynamic head of 192 ft with a 12-ft suction lift. They have 30-in.-dia suctions, 24-in.-dia discharges, and are equipped with a fully automatic priming system.

After discharge from the pumps, the water passes through Andale rotary strainers which remove the fine materials not caught by the traveling screens. By now the screened and limed water is ready to play its part in the making of steel. It leaves the intake in two 36-in. steel pipelines, and after passing through a drainage sump pit just upstream of the intake, where pressure and volume are Bailey-metered by the orifice method, it is piped to locations of eventual use.

Just downstream from the river intake is the liming plant. Here from either of two 50-ton-capacity steel silos, pebble lime is fed to two 2,000-lb-per-hour Omega continuous lime slackers. The quantity of lime water fed to the wet wells, as mentioned before, is automatically regulated by a Bailey Meter Co. and Leeds & Northrup lime control system.

The Machinery Division of Dravo Corporation, working with the Contracting Division, furnished and installed the pumps, piping, equipment and superstructure. Original general layout drawings were made by the Swindell-Dressler Corporation, which also had charge of field engineering and inspection. Design and detail drawings were prepared by Dravo and approved by W. H. Wachter, Assistant Chief Engineer of Jones & Laughlin. The writer was project engineer for Dravo.

In view of completed building, intake forebay is seen at near end, at left, extending 12 ft riverward of main structure. At right are lime storage silos on top of lime slaker building.

Promising future predicted for precast

ARSHAM AMIRIKIAN, M. ASCE., Chief Designing Engineer, Bureau of Yards and Docks, Department of the Navy, Washington, D.C.

As is generally the case with new techniques, the acceptance of precast concrete construction has been slow. However precasting has now gained sufficient momentum to initiate a new era of profitable construction.

In the abbreviated terminology of the building industry, "precast work" is generally used to indicate the prefabrication of reinforced concrete framing elements. A structural assembly composed partly or wholly of such pre-made components is similarly called "precast framing." In "conventional precasting," relatively simple formwork is used to cast isolated framing members of shapes and thicknesses comparable to ordinary poured-in-place concrete construction. By contrast, in "thin-shell precasting," rather elaborate molding devices and special handling equipment are utilized for the production of composite framing elements consisting of a thin slab and stiffening ribs, arranged to form miniature systems of framing of any desired shape. Important elements and trends in both of these general classifications will now be discussed.

Conventional Precasting

Conventional precasting includes: (1) simple framing members, (2) wall panels, and (3) rigid frames.

Simple framing members comprise beams and columns of solid rectangular cross section, cast either at the job site or at the factory, in varying lengths and weights adapted to the handling facilities. Their use is limited to simple assemblies where moment-resisting joints or connections are not required. The present production volume of such members is small and future prospects for increased production are dim.

Wall panels, on the other hand, are being constructed of precast concrete in large volume. Such panels are particularly favored for one-story industrial buildings, often in conjunction with steel or timber framing. They are cast at the job site in segments a story high and of varying lengths. Their thickness also varies, from 4 to 10 in. The reinforcing arrangement in most cases conforms to conventional practice. Their main advantage lies in the simplicity of the formwork, which consists merely of a casting platform and a peripheral bulkhead. In some cases, the floor slab of the building is utilized as a casting platform, each panel being cast directly adjacent to its foundation, in such a way that it can be raised and placed in position by simply tilting or rotating it about its base.

This manner of casting and erection is called "tilt-up precast construction." For small jobs, it may have some advantages but they are generally offset by the restrictions imposed by the presence of the large cast wall panels around the erection site. Therefore tilt-up construction is seldom used on large projects. For such projects wall panels can be produced more conveniently and speedily on a separate casting platform away from the building site.

The sandwich panel, recently developed, is an insulated substitute for the solid-slab wall panel. This new type of panel is obtained by placing a layer of insulation between two slabs of concrete to form a laminated element (Fig. 1). Insulation may consist of foam glass, fiber glass, or other material. The two slabs are reinforced with wire fabric and connected by a series of shear ties consisting of segments of wire mesh or expanded metal and a peripheral strip of concrete. Structurally and functionally, the sandwich panel constitutes a good framing element, particularly suitable for use in structures where insulation is an important consideration. However, its fabrication is considerably more costly than that of a solid-slab panel.

Rigid frames made up of precast elements are practicable. As previously stated, the structural efficiency of a precast assembly composed of simple-frame elements is very poor. To remove this difficulty, in a number of recent designs of precast framing, the component members are so arranged and shaped that, when assembled, they form a rigid frame. For this purpose, the connections or splices are located at or

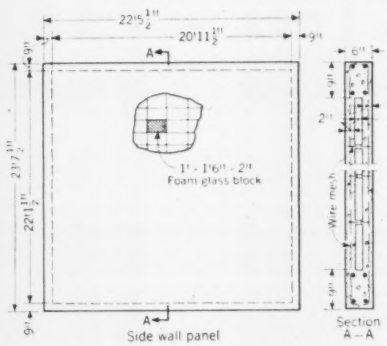


FIG. 1. "Sandwich panel" consists of two concrete slabs reinforced with wire fabric, with layer of insulation between. Typical panel (left) was used on recent project.

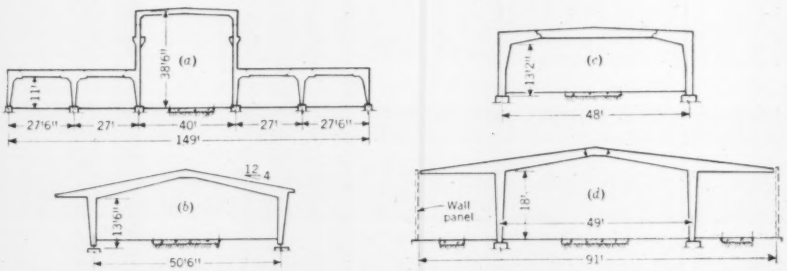


FIG. 2. Typical precast rigid frames (below) for Navy projects follow conventional designs. Dotted lines indicate field connections, made by welding reinforcing steel and grouting joint pockets. (a) is main frame of shop building, one of earliest applications of this type of framing; (b), (c), and (d) represent main framing of personnel and facility buildings currently under construction.

thin-shell construction

near points of inflection of the frame, and the members are made in varying shapes and depths in accordance with the stress pattern. Some typical examples of rigid framing, used on various types of Navy projects, are shown in Fig. 2. Field connections, shown by dotted lines, are accomplished by welding the reinforcing steel and grouting the joint pockets.

Thin-Shell Precasting

Thin-shell precast concrete framing is an entirely new development in the field of concrete construction, developed by the writer and extensively used in Navy work. This type of framing is characterized by its unusual lightness and efficiency of arrangement. For discussion purposes, its applications are grouped under three headings: (1) ribbed panels, (2) hollow-section frames, and (3) cellular framing.

Ribbed panels are the basic elements in thin-shell precast framing. They may be shaped to conform to any desired profile and outline, and used either as a secondary or primary framing. At present, their use is confined to roof and wall framing of single-story buildings. The panels are cast at the job site, in concrete, steel or plastic molds, and usually removed from the molds by the aid of vacuum-suction lifts. Current Navy projects alone include over 7,000,000 sq ft of panels of this type. Details of a typical roof panel used in standard Navy warehouse framing are shown in Fig. 3. While most contractors favor the 5-ft width of panel shown, a few consider a 10-ft width more economical. Still larger panels, up to 25 by 25 ft, are sometimes used for warehouses.

Ribbed panels are equally adaptable for framing prefabricated buildings and shelters. In such applications, the entire assembly may be composed of panels alone. For example, a polyhedral dome framing may be formed by assembling, in horizontal tiers, trapezoidal panels of the shape outlined in Fig. 4. Similarly, a gable or circular arch frame may be built by using the panels shown in Figs. 5 and 6. Frames up to 50 ft of span can be constructed economically, provided the number of structures is sufficiently large to permit mass production using proper casting and handling facilities. However, only limited use has been made of these specially shaped panels.

Hollow-section frames are coming into use. Although a member of hollow cross-section and of tapering depth is difficult to cast in one piece, a practical simplification is readily obtained by casting the member in two longitudinal half segments. Each segment thus becomes a ribbed panel, its varying width corresponding to the tapering depth of the completed member, and its diverging longitudinal ribs representing the two half-flange sections. Accordingly, a girder or frame of hollow cross-section, and of any desired outline, can be considered merely as an assembly in pairs of ribbed shell panels, connected along the abutting flanges and spliced at points of favorable stress.

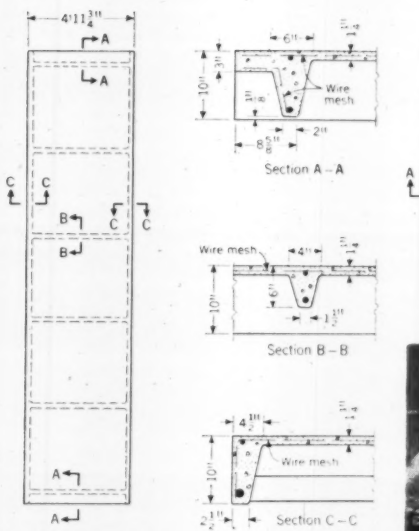


FIG. 3. Thin-shell ribbed roof panel is used in standard Navy warehouse framing. Panel size may vary up to 25 × 25 ft.

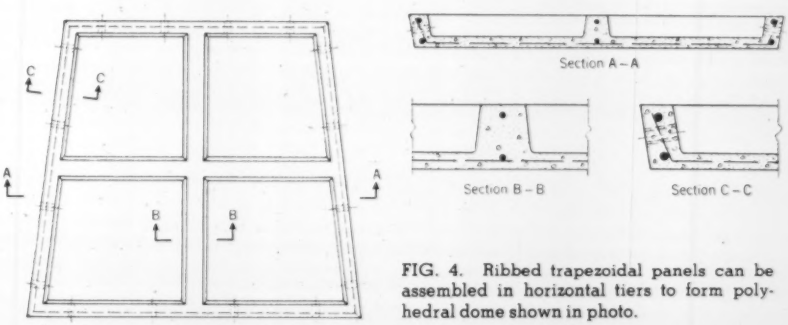


FIG. 4. Ribbed trapezoidal panels can be assembled in horizontal tiers to form polyhedral dome shown in photo.

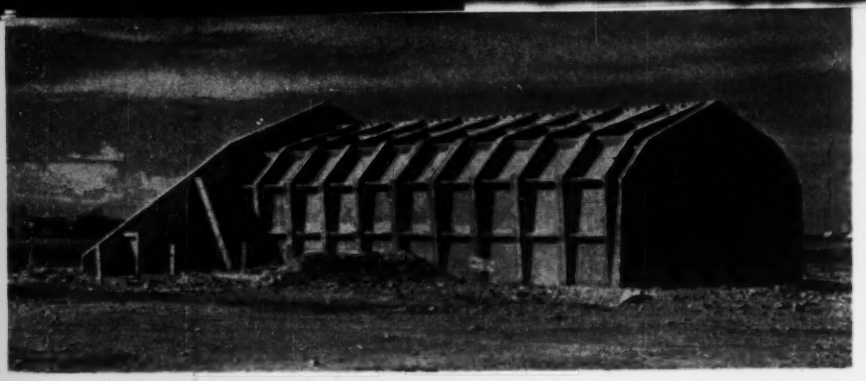
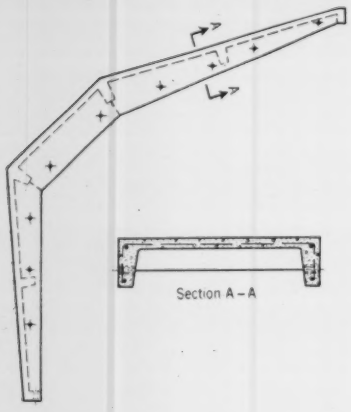


FIG. 5. Angular ribbed shell panels are employed to build up gable frame. Panels in photo have ribs on outside instead of inside as in cross-section at left.



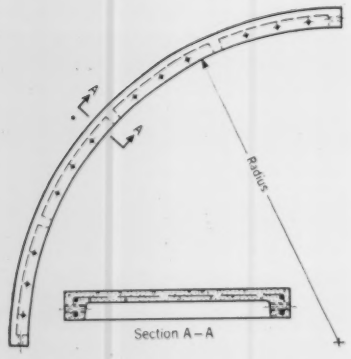


FIG. 6. Curved ribbed shell panels can be used to form circular arch frame.

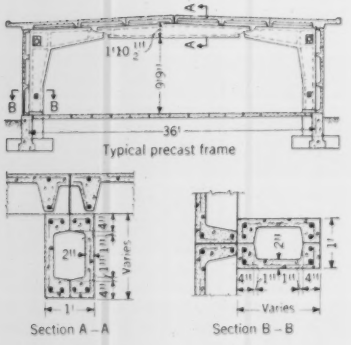


FIG. 7. Thin-shell framing assembly of hollow bents and ribbed panels has been recently standardized for Navy construction. Hollow girder is conveniently precast in two longitudinal half segments, spliced at points of favorable stress.

A typical arrangement, taken from a new Navy standardized building framing, is shown in Fig. 7. The details of jointing and connection are similar to those used in a precast concrete warehouse described by the writer in the *Journal* of the American Concrete Institute for June 1947. The great efficiency and inherent economies of this framing have not as yet been fully recognized and utilized by engineers and builders.

Cellular framing has as its basic precast element an open-ended box of relatively thin walls, obtained by special casting procedures. By arranging the boxes in a checkerboard pattern, the resulting cellular assembly will provide a new framing scheme adaptable to many structural purposes, such as floors and walls, where a divided thickness is desired for greater strength and reduced weight. This framing method was developed by the writer during the later stages of World War II as a practical means for utilizing concrete framing in floating structures. Except for two applications, in the form of two experimental floating craft built by the Navy, the possibilities of this framing scheme remain to be explored.

Factory-Cast Floor Units

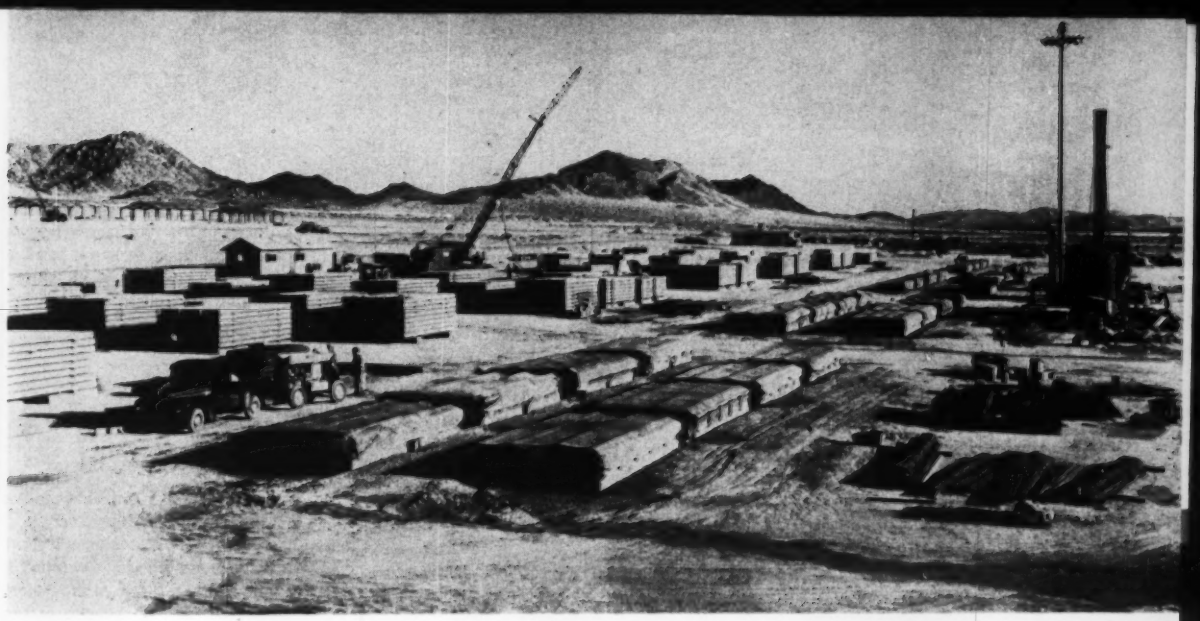
There is another group of precast framing elements which cannot be properly classified under either of the two main categories previously discussed. This is the group of factory-produced structural members generally used as local framing elements in floors and roofs. It includes floor joists of solid or hollow cross-section, channel-shaped slabs of short length and thin section, and concrete planks made of various lightweight aggregates. These elements are produced by efficient casting procedures under fully controlled conditions which assure economical fabrication, but their adaptability or range of utilization is confined to conventional simple framings. As proprietary products, their use is advanced through aggressive promotional activity. The competitive position of these factory-cast units, which are often premade and stocked, is particularly favorable for relatively small jobs where the required framing elements cannot be provided economically by other methods or types of members.

Of the various methods of precasting, the thin-shell technique offers the greatest opportunities for economical application. Its structural efficiency is indicated by the weight of the resulting framing. A thin-shell framing made up of ribbed panels and hollow-section frames contains less than one-half the amount of concrete required for a comparable poured-in-place framing. This important reduction in framing weight is, of course, reflected by corresponding savings in the weight of reinforcing steel, as well as in the reduced burden on the foundations.

In so far as the cost of production is concerned, possibilities of further economies, mainly through improved procedures of casting and handling, are equally promising. As an indication, it is to be noted that ribbed panels of the types and sizes shown in Fig. 3 are now obtainable at as low a price as 60 cents per sq ft, erected in place. Although this is a very attractive price considering that the corresponding cost of concrete would be about $80.00 per cu yd, it is still too high, and further reductions may reasonably be anticipated.

As is perhaps not generally realized, the two techniques of precasting and prestressing are not competitive but complementary. In reality, their common objectives of conserving materials and reducing construction costs are achieved by the same means. In either case the greater part of the saving is obtained from precasting—as compared with poured-in-place construction. Any improvements in precasting are of equal importance and benefit to prestressing. The latter process simply adds another advantage in the form of savings in the amount of steel. Similarly, in prestressed work the use of framing arrangements such as those here described under thin-shell precasting would be more advantageous than assemblies composed of conventionally shaped members.

(This article is taken from the paper by Mr. Amirikian presented before a Structural Division session at the Inter-American Convention of Civil Engineers in Puerto Rico. The presiding officer at this session was Paul Lucchetti, A. M. ASCE.)



Central casting yard for roof panels is symmetrical about boiler at right, which provides steam for curing. Roof panels being cured are under canvas covers, others are stacked at left.

Precast concrete permits rapid construction of large Marine training center

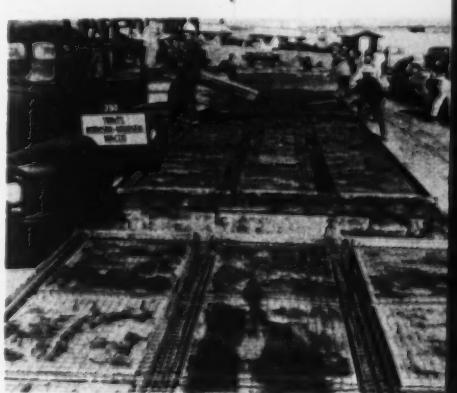
D. G. HALL, A. M. ASCE Project Manager, Twentynine Palms Project, Twentynine Palms, Calif.

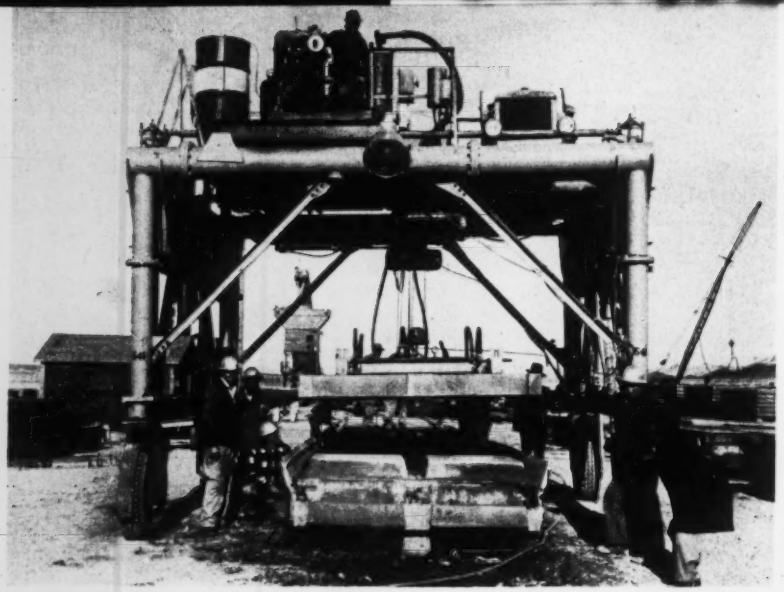
Currently under construction at Twentynine Palms, Calif., is one of the largest precast concrete building projects yet undertaken. When completed, the project will provide Artillery Training Facilities for the United States Marine Corps.

After the Mojave Desert site was chosen, the Eleventh Naval District directed the firm of Neptune and Gregory, architects and engineers, to conduct cost studies of precast concrete construction as compared with the modified quonset-type building originally intended. The cost studies indicated that, with a precast type of construction, all the advantages of a permanent concrete building could be obtained at a cost no greater than that for quonset construction, while at the same time providing equally adequate facilities. On receipt of approval of the precast construction, the architect and engineer, Neptune and Gregory of Pasadena, Calif., began their design for the contract.

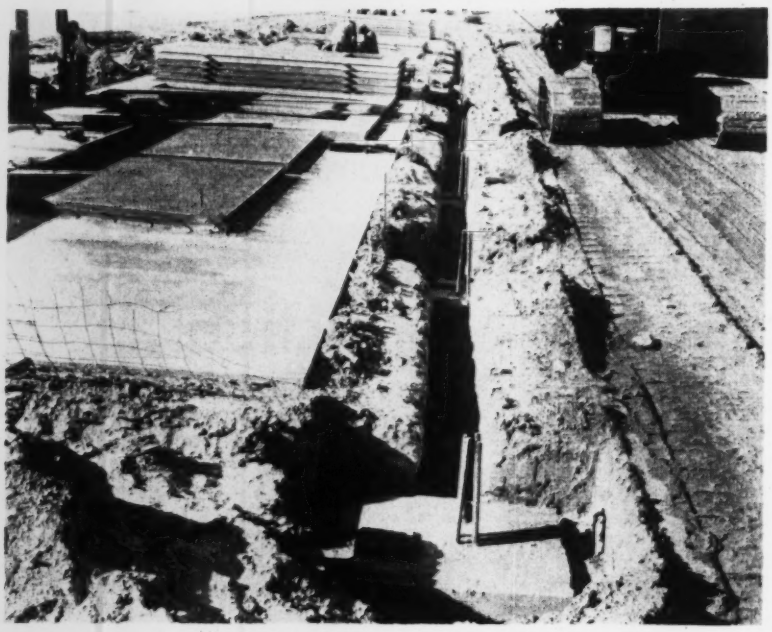
After receiving competitive bids, the Navy Department awarded this contract, for about $9,000,000 to Ford J. Twaits Co., Morrison-Knudsen Co., Inc. and Macco Corporation, joint venturers, for construction of the following items: 76 enlisted men's barracks with a floor area of 6,600 sq ft each, 10 bachelor officers' quarters, 6 battalion administration buildings, 6 one-thousand-man mess halls, 12 storage buildings, 6 instruction buildings, and complete utilities, including sewage treatment facilities and a liquid petroleum gas distribution system. All buildings are of precast

Reinforcing steel and welded wire mesh are in place in roof panel forms, and concrete is being placed by adjustable chute from dump truck.





Top:
Straddle-type lumber carrier was modified for use in lifting roof panels from forms and transporting them to stock piles. Vacuum mat is seen holding panel which has just been lifted from form.



Center:
Wall panels are cast directly on floor slab of building in which they are to be used. Stacking of panels (background) permits use of limited area for more than one pour. Footing for rigid frame, with reinforcing steel dowels protruding, appears in foreground. Grout pad on footing positions wall panel for erection.

Bottom:
First erection step after pouring of floor slab and footings is placing of wall panels on footings by means of lifting mat maneuvered by crane, employing atmospheric air pressure only for vacuum. Roof panels are placed by same crane and vacuum mat.

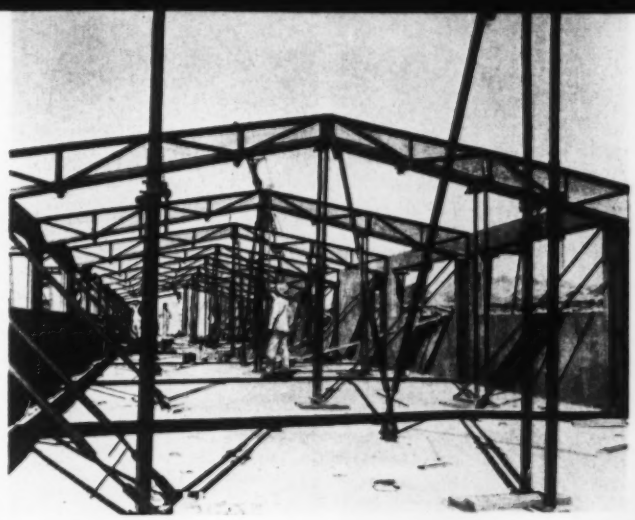
concrete design except those for instruction and storage, which are of prefabricated steel on a concrete floor slab.

Since beginning work on the initial contract, the same joint-venture combination has been awarded additional contracts which bring the total to $13,000,000.

Precast Building Elements

The superstructure of all the concrete buildings consists of three components—precast roof panels, precast wall panels, and poured-in-place rigid frames spaced 20 ft on centers. The roof and wall panels are standardized to conform with the 20-ft building bay. The rigid frames span a distance of 30 ft. With the exception of the mess halls and the theater, all the concrete buildings utilize the standard 30-ft rigid frames, the length of the building being determined by the number of 20-ft bays it includes.

In the mess-hall structure, the 20-ft bay distance was used for uniformity of roof and wall panels. Mess halls, being T-shaped in plan, incorporate rigid frames of two different



Right:
Rigid-frame forms spaced 20 ft on centers are in place in barracks building 30 ft wide. When precast roof panels have been placed, pouring through openings between them will fill forms and at same time connect precast wall and roof panels into unified whole.

Left:
Crane with vacuum mat places roof panel on barracks structure. Vacuum pump unit is located in back of crane cab, just inside window.

Right:
In exterior view of barracks building, piping is for high-temperature hot-water distribution system.

sizes. The bays of 50-ft rigid frames make up the cross of the "T," or dining area, while the 40-ft frames with 20-ft side frames comprise the stem, that is, the galley part. The length of the galley is 140 ft.

A central casting yard which adjoins the project is used for the production of precast roof panels. A total of 5,806 panels was required, of five different types, although all are modifications of the basic panel type, which is 20 ft × 11 ft 2 in. All roof panels are of thin-shell construction incorporating a $1^1/_4$-in. slab throughout, with longitudinal T-beams 6 in. wide by 8 in. deep spaced 3 ft $8^5/_8$ in. on centers and, for cross bridging, T-beams $2^1/_2$ ft × 4 in. spaced at 3 ft 8 in. on centers.

Sixty waffle-type metal molds with hinged side forms and concrete foundations form the casting tables for the roof panels. The tables are so arranged in the casting yard that steam generated by a centrally located boiler is distributed through underground piping to each table, where the steam is directed into chambers formed by waterproof canvas placed over the table. The canvases are supported to form a 6-in.-high chamber over the entire top surface of the concrete in the form, thus allowing a considerable volume of the steam (at 170 deg F) to contact the concrete panel during curing. After seven hours of such curing, the concrete has reached 60 percent of its design strength of 4,000 psi, and, by using a vacuum lifting mat to distribute the load, the precast roof panel can be stripped from the mold and handled without fear of damage due to overstressing.

For the stripping, storing, and other operations involving handling of roof panels, a special device is required. The answer to this problem is a remodeled and specially equipped straddle-type lumber carrier which can be maneuvered under its own power to a point directly over the roof panel to be handled. The original lumber carrier was widened to a 16-ft tread and extended vertically to obtain a 12-ft clearance. A gasoline-engine-driven vacuum pump and a diesel-electric generator are attached to the platform of the carrier. The vacuum unit provides the force (10 to 12-psi atmospheric pressure) with which the vacuum mat is attached to the roof panels, and the generator affords current for the electric cable hoists which raise and lower the vacuum mat.

Production in the central casting yard is based on a 24-hour cycle and a single shift per day. However, for a six-week period, a two-shift, 12-hour cycle was required to meet erection demands.

The production cycle in the casting yard for roof panels involves eight major operations:

1. **Antibond application.** The sides and bottoms of the metal forms are sprayed with a chemical parting agent which prevents bond between the concrete roof panel and its form.

2. **Placement of reinforcing steel and mesh.** Bar reinforcing steel is placed in the beam forms, and welded wire mesh of 2-in. No. 12 wire in both directions is secured to the top beam steel for slab reinforcement. Also included in this step is the placing of special anchoring devices, many of

these being required for the attachment of mechanical, electrical and air conditioning equipment after the roof panels are in place.

3. **Squaring and aligning side forms.** The hinged side forms are swung into position, secured and adjusted by metal keying wedges.

4. **Placing of concrete.** Air-entraining concrete ($^1/_2$-in. maximum sized aggregate), mixed at the batching plant, is transported to the roof-panel mold by hopper-type dump trucks. When the truck body is elevated, the discharge gate is opened, allowing the concrete to flow down a chute attached to the truck. The chute extends to the center of the roof panel form, where the concrete is deposited in a berm, then raked level by hand.

5. **Screeding and vibrating.** After the concrete is hand raked to all parts of the form, an internal "stinger"-type vibrator is inserted in the beam sections, after which a vibratory screed is pulled throughout the length of the roof panel. The vibratory screed not only vibrates the $1^1/_4$-in. slab portion of the panel, but strikes off the excess concrete, giving a uniform slab thickness. The strike-off is accomplished by letting the overhang of the screed ride on the side forms of the mold. Two pneumatically driven vibrator motors provide vibratory energy at 10,000 cycles per sec.

6. **Concrete finishing.** After the mortar is brought to the surface of the panel by the application of wood floats, a canvas belt made from fire hose is worked in oscillating lateral "strapping" movements sidewise across the roof panel throughout its length. It is important that the surface created by the strapping action be free from gross irregularities, which would impair the operation of the vacuum lifting mat when in place on the panel.

7. **Curing.** The curing operation involves three steps, the first of which is spraying the exposed portion, or top of the roof panel, with a residual wax type of curing compound. Application of the curing compound immediately follows the finishing operation. After two hours, during which time initial set takes place, the waterproof canvases and their supports are placed over the panels. The canvases overhang all edges of the form, and are folded and tied to prevent loss of steam. By means of a flexible 6-ft hose, connected on one end to a steam outlet valve under the table form, steam is directed into the chamber formed by the roof panel top and the canvas cover.

After seven hours of application, the steam is shut off but the canvas covers are not removed until just before the panel is to be stripped from its form. With the vacuum lifting mat attachment providing the holding force, the straddle carrier removes the finished panel from its form and stores it in a stack seven panels high. All panels are retained in the storage stacks for at least ten days before being placed on the buildings. While in the storage stacks, the newly cast panels are supported on 2 x 6 "stickers" placed at the fifth points of the longitudinal beams in order that their $^1/_2$-in. original camber will not be lost due to sag.

Immediately after a form is stripped, its entire surface is scraped by means of long-handled scrapers, and any loosened residue is blown off by compressed air. The form cleaning process completes the casting cycle, which is launched again with the application of the antibond agent.

One more function of the casting yard is to dispatch the properly aged roof panels from the storage stacks to the building for which they are intended. When removed from the form each panel is marked with the date of casting, type of panel, and code indicating insert placement position. As the various types of panels are required for erection they are selected from the stacks, picked up by a truck crane equipped with a vacuum mat, and loaded on a semi-trailer truck for transportation to the building site.

Wall Panel Cast on Building Slab

Wall panels, the majority of which are 11 ft 6 in. high by 19 ft 1 $^3/_4$ in. long, and 5 in. thick, are all cast horizontally on the floor slab of the building in which they are to be placed. Lightweight aggregate concrete weighing 104 lb per cu ft, with 4 percent by volume of entrained air, is required for wall panel construction. The structural design did not require the use of lightweight aggregate, but proper functioning of the air conditioning equipment was dependent on the conductive properties of the exterior walls, and only lightweight expanded clay aggregate afforded the proper coefficient of thermal conductivity.

Angle-iron forms of 5 × 3 × $^3/_8$-in. stock provide perimeter limits, while window openings are blocked out with wooden frames which support drilled, sash-holding, window surrounds. The 5-in. legs of the angle-iron forms are punched to allow the horizontal reinforcing steel to protrude 10 in. Wall-panel reinforcing steel consists of No. 4 reinforcing bars on 16 in. centers, placed both horizontally and vertically through the center of the 5-in.-thick slab. Door frames of 5-in. channel iron are made an intregral part of the wall panel, as they are secured in their proper position in the panels at the time of concrete pouring.

The wall-panel casting sequence is a simple one compared to that for roof panels. First, the forms are laid out at their proper location on the building floor slab, and antibond agent is applied to the floor slab and forms. The hard troweled floor slab provides the smooth form for the inside face of the wall panel, which is cast with inside surface down. The outside surface is wood-float finished for rough texture. Reinforcing steel, window blockouts and door jambs are then positioned, and 100-lb shot bags are used to keep them in place during pouring and vibrating. Pouring was found to be most successful when a crane with a concrete bucket was used to place the concrete in the forms. When $1^1/_2$ percent of calcium chloride is used, the wall panels have enough strength 48 hours after pouring to allow them to be lifted from their casting place and stacked elsewhere on the floor slab. This stock piling of wall panels is necessary when curbing, drains and piping reduce the casting area on floor slabs. By this means the limited casting space can be utilized for more than one pour.

Before the concrete in a wall panel has set, a template is placed along the sides where the panel will join the poured-in-place rigid frame. With the aid of the template, holes are punched through the 5-in. wall to provide fastenings for the angle iron and plywood forms for the rigid frames.

Building Erection Procedure

When the building floor slab is to be used as the wall-panel casting surface, it is purposely terminated 3 ft from the inside surface of the wall panel it is to join. This 3-ft space allows room for the wall trench (which is 2 ft deep) and for the isolated rigid-frame footings (which are 4 ft square by 2 ft deep). Not only the rigid frames, but the end points of the wall panels, rest on the footings. To eliminate any wedging or shimming of the panels, grout pads approximately 6 in. square are formed at the points on the footings where the wall panels are to be set. These pads are set to proper grade below the finished floor by means of a large plate attached to the bottom of a level rod. With the pads predetermining the elevation,

the wall panels are erected and temporarily secured by means of diagonal shores. All wall panels are handled with a vacuum mat which can be tilted 90 deg from the horizontal pickup position to the vertical placing position. Tilting is accomplished through a system of pulleys and cable, actuated by the crane to which the vacuum mat is attached.

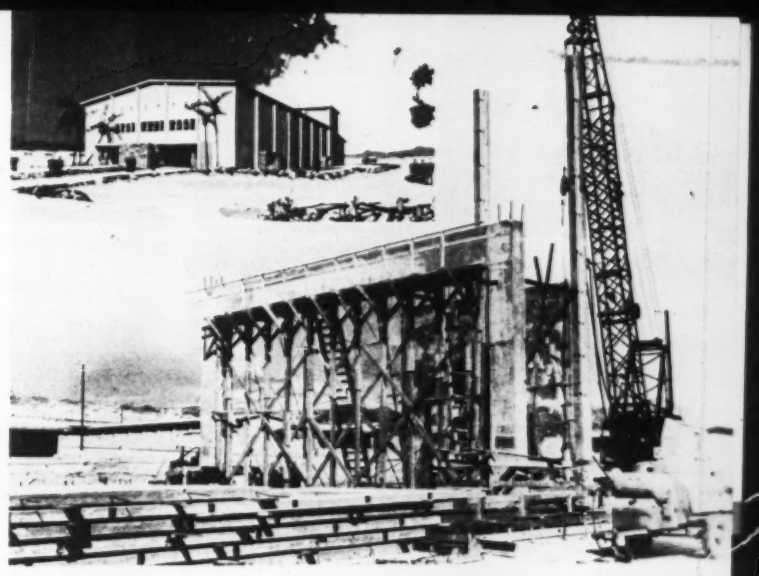
Next step in erection is the assembly of the rigid-frame forms. These forms, of 3 × 3 × $^1/_4$-in. angle iron and $^5/_8$-in. plywood, are fastened to the wall panels by bolts placed through the holes formed in the wall panels during casting. Since the rigid-frame forms must take the load of the roof panels in addition to the weight of the concrete they will receive, they are supported by adjustable metal shores.

With the frame forms properly squared and adjusted to line and grade, the reinforcing steel for the rigid frames is placed in the forms. Next, the roof panels are placed in position on the frame forms. Placement of roof panels, like all operations requiring handling of precast units, is done with a crane-mounted vacuum mat. The roof panels are constructed so that there will be openings where they meet each other over the rigid-frame forms. Through these openings, the concrete is poured and is vibrated into the rigid-frame forms.

By reshoring the rigid frames at their quarter points with 6 × 6-in. timber columns, the frame forms and metal shores can be removed 48 hours after pouring. Reshoring was necessary to meet the production schedule calling for erection of two barracks-type buildings per day, using a limited number of rigid-frame forms.

The openings in the roof panels through which the rigid frames are poured are filled with concrete, and the pouring of this keystone-shaped opening positively fastens the roof panels to the rigid frames. Since all horizontal wall-panel steel protrudes into the rigid frames 10 in., in addition to $^3/_4$ in. of the wall panel itself, it is evident that the pouring of the rigid frames creates an unjointed, solid structure from many individual precast parts.

Structural completion of the building is accomplished by pouring the remaining 3-ft-wide perimeter portion of the floor slab. No. 4 reinforcing-bar dowels projecting from the major floor slab, and from the wall panels, into the 3-ft perimeter floor slab tend still further to unify the precast components of the building.



In construction of theater, proscenium arch at center was poured in place. Behind it, 60-ft precast column is being erected. Insert shows drawing of completed building. Stage section at rear is 60 ft high, rest of building 40 ft high.

Rigid-Frame Construction Method Changed

The above described method of pouring the rigid frames in place in the 30-ft-wide buildings was used only on the initial contract. On all later contracts the rigid frames were of precast construction, as this method was found to be less costly. Weld plates, to which wall and roof panels could be welded, were cast into the precast rigid frames. This necessitated a slight modification of the roof and wall panels so that the protruding reinforcing steel could be used for erection welding purposes.

In this later method the frames are cast on the building floor slab in two stacks, using metal forms that form one frame at a time. The forms are so constructed that they use the upper surface of the preceding frame for the soffit of the frame being formed. Included in the bottom frame of each stack is the end wall panel for the building, which is poured monolithically with the end frame.

Novel Theater Building

Of particular interest is the construction of a 90 × 180-ft theater building. All wall panels of this building are 20 ft × 20 ft × 6-in. thick, and were precast on the floor slab. Wall panels are grouped two and three high to join 40- and 60-ft precast columns, forming the wall structure of the building. Wall panels are joined to columns by weld-plate inserts in the concrete. The possibility of a poor fit at the joint between a wall panel and a column was eliminated by first casting the wall panels on the floor slab in their exact position in relation to the columns they join. Antibond chemical was applied to the ends of the wall panels and the columns were formed and poured in the position they would occupy with respect to the wall panels.

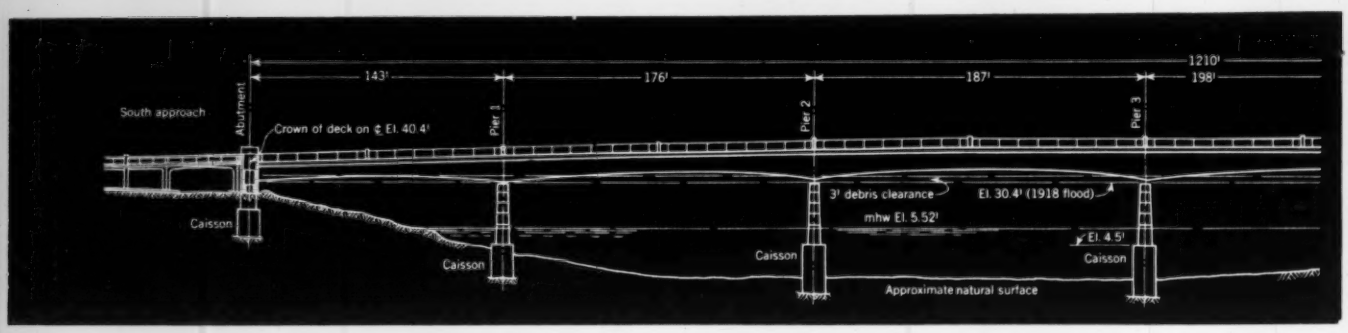
From the contractor's viewpoint, if it is possible to mass produce a great number of relatively identical units, then the precast type of construction is a very acceptable and economical building method. Most important in actual field construction is the training of craftsmen to visualize the precast components as they will appear in the completed structure. The craftsman must have a mental picture of the final assembly in order to properly interpret, with a minimum of error, the drawings and diagrams of openings, inserts, and other configurations of the precast concrete component that he is assigned to construct.

In precast construction, joinery tolerances are of utmost importance. The designer should be aware of the accuracy limits of the construction operation, and govern his design requirements accordingly.

Participants in the Twentynine Palms Marine Corps Training Center Project are as follows: Contractor, Ford J. Twaits Co., Morrison-Knudsen Co., Inc., Macco Corporation, Los Angeles, Calif.; owner, Eleventh Naval District; architect and engineer, Neptune and Gregory, Pasadena, Calif.; and structural engineer, John K. Minasian, A. M. ASCE, Pasadena, Calif.

Australia completes its longest plate-girder bridge

J. A. HOLT, Chief Engineer, Coordinator General's Department, Queensland, Australia



The new Fitzroy River Bridge at Rockhampton, Queensland, opened to traffic on September 27, 1952, has a total length of 1,210 ft between abutments, and a maximum span of 198 ft, making it easily the longest continuous plate-girder bridge in Australia. The girder design incorporates a web with an unusually high ratio of depth to thickness, stiffened vertically and horizontally on one face only.

The city of Rockhampton, with a population of 43,000 is situated on the Fitzroy River about 40 miles from its mouth. The business area, and the larger part of the city, are to the south of the river but a considerable population resides to the north. The new bridge carries local traffic as well as vehicles traveling on the main coastal highway which passes through Rockhampton, and accommodates one 24-in. and two 18-in. water mains, as well as gas mains, power cables and telephone conduits.

This structure replaces a four-span eyebar chain suspension bridge, opened in 1881, which had become both inadequate and unsafe. It is located 60 ft upstream of the old bridge. Clearance above the river was dictated solely by flood considerations, as navigation for any distance upstream from the bridge is prevented by a rock bar extending across the channel. At the bridge site the river is tidal with a range of about 10 ft 6 in. between high and low spring tides.

The main river crossing has a total length of 1,210 ft, made up of seven spans varying in length symmetrically about the center span, as shown in Fig. 1. The roadway is 42 ft wide, and the two footways are each 5 ft wide (Fig. 2).

Choice of the continuous plate web girder design was based on its low relative initial and maintenance costs, its attractive appearance, and ease of erection. In fact, ease of erection was a major consideration in the design and planning of the whole structure. The Fitzroy River, like most rivers on the northeast coast of Australia, is subject to sudden and severe floods; consequently any extensive falsework in the main channel would entail considerable risk. Use of the cantilever method of erection of the continuous plate girders required falsework only under part of the first span adjacent to the southern bank, and left the river channel completely unobstructed during the rest of the construction period.

The south approach, with a total length of 228 ft, distributes traffic from the bridge to a square adjacent to the main shopping center of Rockhampton. It comprises a 65-ft length of fill between concrete gravity retaining walls, about 100 ft of reinforced concrete beam-and-slab construction enclosed by 6-in. curtain walls, and a reinforced concrete span over a roadway along the river. On the north, the bridge approach is approximately 1,040 ft long and consists of a long earth bank terminating in an underpass adjacent to the north abutment. About halfway along the earth bank, the approach is carried over a railroad and highway on a two-span overpass.

River Piers Founded on Rock

Substructure design was based on information secured from a series of wash borings taken about on the center line of the bridge. These borings disclosed a varying depth of clay or alluvium over a basalt sheet, which varied from weathered basalt to sound blue rock. However, material encountered during sinking of the caissons showed the bore logs to be somewhat inaccurate.

On the south bank, the overlying material consisted chiefly of clay, known to extend to a depth of at least 20 ft below the natural surface,

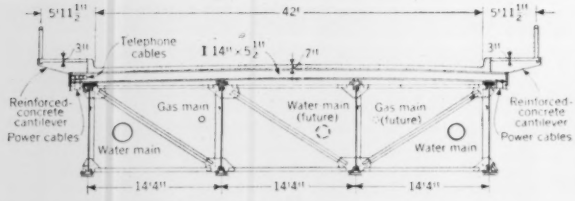
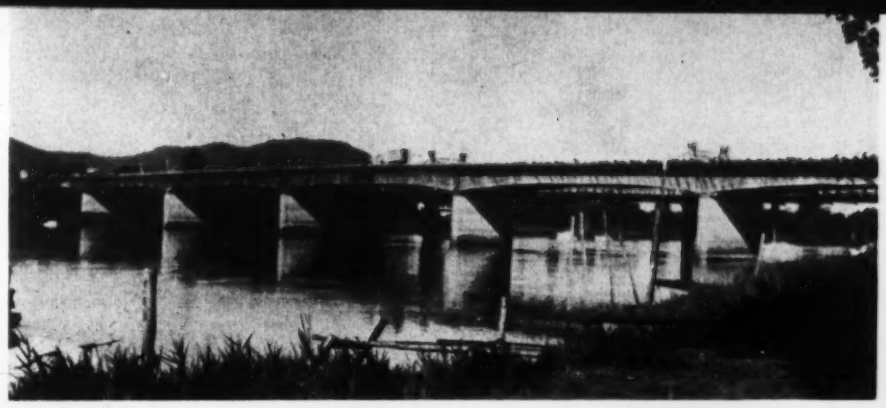


FIG. 2. Four girders side by side, cross braced, carry deck, as seen in cross section through roadway.



Clean lines, low maintenance, and erection without falsework were governing considerations in design of highway bridge 1,210 ft long over Fitzroy River, Queensland, Australia. Seven-span plate-girder structure is continuous over six river piers.

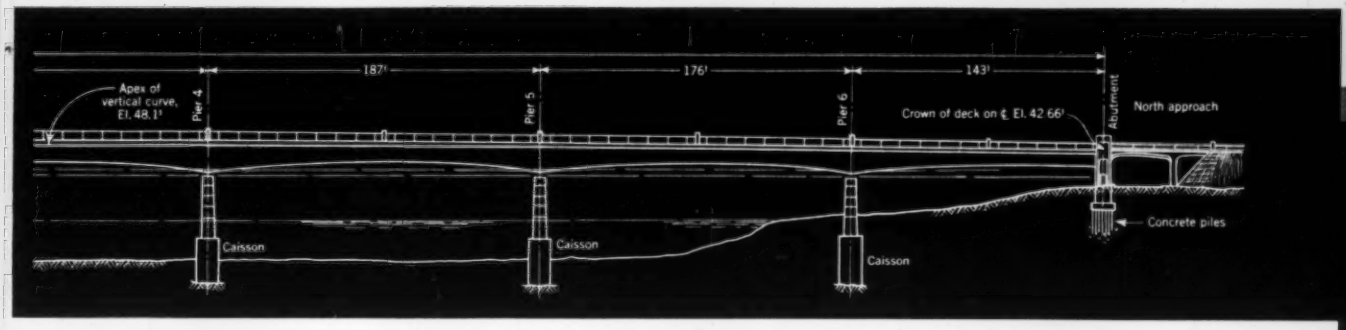


FIG. 1. Use of continuous girders erected by cantilever method eliminated need for river falsework, which would be vulnerable to flood damage.

that is, about 2 ft above mean sea level. "Solid blue rock" was indicated by the bores at El. −40. On the north bank, the bores indicated a depth exceeding 25 ft of sedimentary material overlying the decomposed basalt, with solid blue rock commencing at about El. −60.

The south abutment was designed to resist longitudinal forces, braking, friction and longitudinal wind acting on the 1,210-ft length of the main girders. Its location over about 20 ft of clay ruled against a pile foundation; instead it was founded on a spread footing constructed as an open caisson, sunk to weathered basalt at El. 0.0. For the north abutment, designed as a pile footing, point-bearing concrete piles were driven through the alluvium and sandy clay to beds of sand and river gravel.

All the river piers, that is, Piers 1 to 6 in order from the southern end, were founded on caissons sunk to the sound weathered basalt strata overlying the blue rock at depths between Els. −22 and −29.

On the northern bank, test piles were driven at the site of each pile group. On the southern bank, tests were carried out on undisturbed clay samples taken from varying depths, mainly to calculate possible movement of the approach retaining walls.

The south abutment was designed to exert maximum foundation pressures of less than 6 tons per sq ft under combined vertical and overturning loads. The visible part of the abutment consists of a reinforced concrete cellular structure about 9 ft by 65 ft overall, and 10 ft 10 in. high under the main girder bearings, supported on a rectangular reinforced concrete caisson 15 ft by 65 ft by 17 ft 6 in. high, sunk by open excavation from El. +19.25 to El. 0.0 and completely filled with concrete.

Provision of roller bearings at the north abutment relieves it of all but minor longitudinal loads from the bridge. It is carried on a pile foundation with an assumed capacity of 30 tons per pile. A total of 56 reinforced concrete piles, 14 in. square, were driven to refusal in the floor of the abutment excavation, with an average penetration of 14 ft. The piles are point bearing, with their tips at about El. −4, apparently in a bed of river gravel or boulders, and have a minimum nominal spacing of 4 ft center to center. A reinforced concrete slab 15 ft by 66 ft by 3 ft 6 in. thick, was cast around the pile tops, and on this slab the upper part of the abutment rests. The upper parts of both abutments are similar.

Each river pier consists of a slender, solid reinforced-concrete pier shaft, about 30 ft high, extending down to low-water level at El. −4.5 and supported on a reinforced concrete caisson. In section, the pier shaft is rectangular with rounded ends. It is 49 ft long, tapering from a maximum width of 6 ft 9 in. to a width of 5 ft 4 in. at the bearing base-plates, which latter width is the minimum necessary to accommodate the roller bearing under each girder. Temperature reinforcing only is provided, consisting of $^1/_2$-in.-dia bars on 6-in. centers in both directions at all faces.

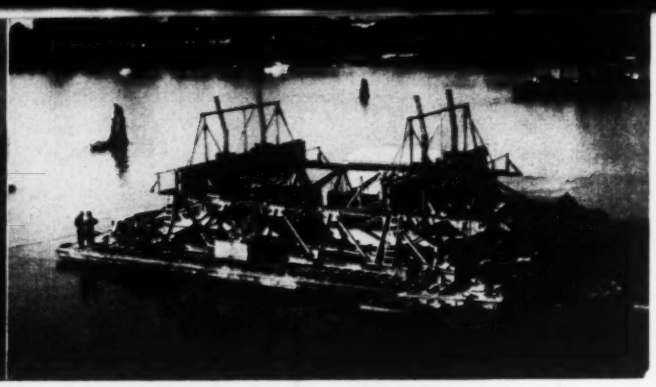
River Caissons Floated Into Place

The foundation for each river pier consists of a reinforced concrete caisson proportioned to give maximum foundation pressures of from 10 to 12 tons per sq ft under combined vertical and overturning loads. The caisson is 52 ft long by 13 ft wide, with semicircular ends, and is provided with a structural steel cutting edge. Walls are 1 ft 6 in. thick, except over the lower 11 ft 7 in., where the thickness increases to 2 ft 6 in. Cross walls, which divide the caisson into five wells, end 3 ft 7 in. above the cutting edge. The final total height of the caissons varies from about 17 ft at Pier 1 to a maximum of 25 ft at Pier 3. The details were determined largely by construction requirements.

The method adopted for sinking the caissons was sufficiently flexible to avoid hazards or long delays during floods, and in fact the caissons survived several floods during the construction period without damage.

Construction of each caisson was started on launching ways 8 miles downstream. When launched, each caisson was suspended between two 90-ton barges, and in this position was built up in stages, then floated to final position, lowered to a level seat previously excavated in the weathered rock of the river bed and

Reinforced concrete caissons for river piers were built on launching ways. Here lower portion 4 ft 7 in. high has been poured and steel form is in place on top to act as cofferdam during launching.



Caisson is towed to pier site suspended between two 90-ton barges. Caisson is suspended from welded cross-girders resting on trussed superstructure. Four articulated hangers connected to 30-ton screw jacks will lower caisson into position on prepared river bottom at low tide.

sunk about 7 ft to final level by excavation under air. During the initial stages, the bottom of the caisson was sealed by a temporary timber bulkhead fitting against the cutting edge. Concrete bulkheads 1 ft thick were cast over the end wells 10 ft 7 in. above the cutting edge. In the three middle wells temporary steel bulkheads were attached to the caisson wells 12 ft above the cutting edge. Before founding, the temporary timber bulkhead was removed.

After founding, the barges were towed clear. Next the two end wells were filled above the concrete bulkheads with sand and water, on top of which were placed concrete plugs 4 ft thick. After the temporary steel bulkheads were removed, 4-ft-thick concrete plugs were placed in the upper ends of the other three wells also, two being pierced by 3-ft-dia steel pipe, connecting the working chamber at the base of the caisson with the man and material locks. The caisson was then sunk about 7 ft to its final level by excavation under air.

A concrete seal 11 ft 7 in. thick was placed in the working chamber of the caisson, and finally the center wells were filled with fresh water, all services were removed, and a further 2 ft of concrete was added to the top over the full area, covering the ends of all projecting pipes, and including dowel bars placed to bond the base of the pier to the caisson plug.

Concrete Handled by Truck

Construction concrete, mixed at a plant near the south abutment, was trucked over the old chain bridge, from which it was placed in the forms either by chutes or by ramps and wheelbarrows.

The concrete seals in the caissons were placed under air, without using the materials lock, by a method which represents a departure from previous practice. Above the top plug of each well, a steel hopper fed concrete, via a flap-type door, to an 8-in.-dia pipe discharging into the working chamber. The lower end of the pipe was closed by a horizontally sliding gate, controlled from within the working chamber by a lever, so arranged that the release of the lever resulted in the automatic closure of the gate. Both gates were faced with rubber to provide air-tight closure. The operation was similar to the passage of material through a materials lock, similar blow-off valves being provided. In use, each pipe passed in turn 9 cu yd per hour, this rate being determined by the rate at which the two mixers could deliver concrete to the hopper.

Superstructure Design

As previously stated, the deck is carried on four main girders spaced 14 ft 4 in. apart with transverse floor beams. Investigation showed that these four girders would cost less than two girders with the conventional stringer and cross-girder deck system. They are riveted plate-girders with parallel flanges except in the vicinity of the piers, where they are haunched. The flanges consist of 8 in. × 8 in. × $^{5}/_{8}$ in. angles with from one to four flange plates 18 in. × $^{3}/_{8}$ in. Web plates are $^{3}/_{8}$ in. and $^{7}/_{16}$ in. thick, and vary in depth from 84 in. in the end spans to 168 in. at the haunched sections over the two central piers. The depth-to-thickness ratios for the webs are unusually high, ranging from a minimum of 190 to a maximum of 340, the depth being measured from toe to toe of flange angles.

Webs are stiffened by single vertical bulb angles placed under the floor beams, and spaced 5 ft 6 in. apart. These stiffeners, riveted to the web plate, lie between the toes of the vertical legs of the flange angles. The horizontal legs of the flange angles are connected to the stiffeners by welding a flange strut between them (Fig. 3). Horizontal stiffening is provided where necessary by single angles riveted to the web plate between vertical stiffeners at approximately one-third the depth of the girder from the adjacent compression flange. Stiffeners on the two outer girders are placed on the inside faces of the webs to enhance the appearance of the bridge as well as to simplify maintenance.

Except for the end spans, the depths of the webs in the girders exceed 84 in. As plates rolled in Australia are limited to an 84-in. width, webs were shop-spliced longitudinally by means of a "Unionmelt" butt weld, where girder depths exceed 7 ft. The distances between field splices of the main girders were limited by two main considerations—transportation of girder sections from Brisbane, a distance of approximately 400 miles, and the requirement under cantilever methods of erection, that the weight of the erecting traveler should not become excessive. The four girders are connected in the plane of the upper flanges by a lateral system composed of starred angles, while the lower flanges are supported by cross frames fabricated from angle sections and spaced at 22-ft intervals (Fig. 3). Structural and rivet steel for the superstructure conform to the requirements of Australian Standard Specifications No. A1-1940 and No. A33-1937 Class D, with a yield point in each case of not less than 35,000 psi.

The concrete roadway deck is supported by 14-in. × 5$^{1}/_{2}$-in. I-beams spaced 5 ft 6 in. center to center, running transversely and bolted to the upper flanges of the main girders. Under each slab, all the transverse floor beams, except the center one (which is anchored), may move relative to the upper flanges of the main girders, in the longitudinal direction

of the bridge. The concrete deck is insulated from longitudinal strains in the upper flanges of the main girders by the provision of slotted holes through which pass the top bolts connecting the floor beams to the girders.

The roadway deck is of reinforced concrete, 42 ft between curbs, with a slab 7 in. thick and curbs 1 ft high. On the vertical outside face of the curbs, reinforced concrete cantilevers 5 ft 6 in. apart, bonded to the roadway joists, support precast footway slabs 5 ft wide and 3 in. thick, arranged with their upper surfaces at curb-top level. The main expansion joint in the deck, placed at the north abutment, is of the interlocking finger type and provides for a movement of about 6 in. A similar joint is placed at the south abutment to accommodate the change of slope at the ends of the main girders. Intermediate slab expansion joints, 55 ft apart, are of the "open-gap" type armored with vertical mild-steel flats 3 in. × $^3/_4$ in.

Each of the four main girders is anchored to the south abutment. Here the bearings under the girders are of the single-rocker type, with a 5-in. knuckle plate bolted to the under side of the girder and fitting over a spherical head on the 10-in.-dia rocker stub. The rocker itself has a radius of 6 in. and transfers its load to a steel base plate 3 in. thick.

At the piers and at the north abutment, the bearings are of the twin-roller type. A typical assembly is shown in a photograph. Rollers at intermediate piers are 16 in. in diameter. A concave seat recessed into the knuckle plate permits rotation of the girders about two axes at right angles. Mild-steel gear teeth doweled to the outside faces of rollers mesh with mild-steel rack plates doweled to base plates and saddle plates. These gear and rack plates will ensure alignment and prevent creeping of the rollers.

The movement of the superstructure relative to the substructure is greatest at the north abutment, where it reaches an estimated range of 9 in. The allowable line bearing pressure for the rollers is based on U. S. Bureau of Reclamation Technical Memorandum No. 399, using a factor of safety of 2. Steel for the bearings is a forged high-carbon steel with a minimum Brinell number of 200.

Caissons were excavated under air and sunk about 7 ft to sound basalt rock. Here air-lock work on caisson for Pier 5 is in progress, with work on Pier 4, beyond it, nearing completion. Remaining piers are ready for girders. Concrete is placed from old four-span eyebar suspension bridge at left, which will be removed on completion of new crossing.

Cantilever Erection of Superstructure

Except for the first two fabricated lengths of each of the four main girders and the four main bearings at the south abutment, all structural steelwork, bearings, and erection equipment were placed by a gasoline-engine-operated derrick crane. This crane weighed approximately 14 $^3/_4$ tons, had a reach of 50 ft, and was designed for a maximum lift of 7 $^1/_2$ tons. It was mounted on rails attached to the upper flanges of the two inner girders and was moved forward on the track by two hand winches as erection proceeded.

All steelwork erected in Spans 2 to 6 was brought to the site as needed, by a barge loaded on the south bank and subsequently moored within easy reach of the derrick crane. For the first and last spans, the steelwork was lifted from storage areas on each bank.

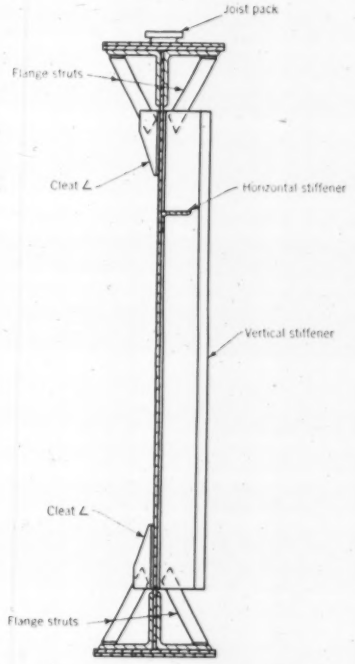
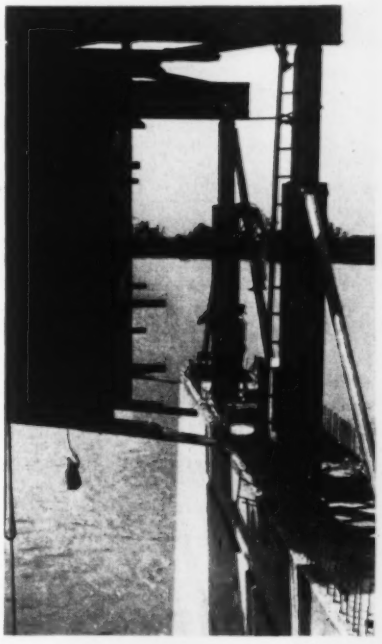
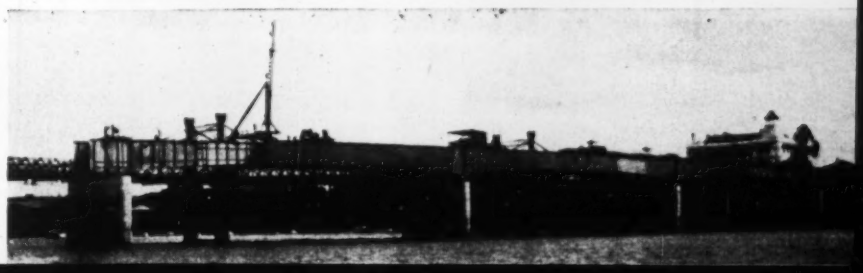


FIG. 3. Cross section through girder shows flange struts and arrangement of stiffeners.

To correct sagging of girder ends as they approached a pier, jacking outrigger was placed so that girders could be seated.



After all four girders had been cantilevered to about midspan, two inner girders were carried ahead and landed on pier, on temporary roller bearings. Erection crane then retreated to bring two outer girders to pier.



Under the adopted system of erection, the only falsework required was in Span 1. The remaining spans were erected by cantilevering from successive piers. During certain stages of the cantilevering process, the vertical reaction on the bearings at the next to the last pier from the cantilever ends was insufficient to ensure lateral stability of the main girder bearings against wind. To correct this condition, a temporary wind anchor was devised in the form of a reinforced concrete block constructed on each of the river piers and on the south abutment. On both the vertical faces of the block parallel to the center line of the bridge, a bearing-plate was grouted and bolted into place. The wind-anchor strut embracing the wind-anchor block was bolted to the sway gussets of the lower flanges of the two inner girders. Roller units of $17^1/_2$-in. diameter were brought into operation by adjusting wedges between bearing plates and gusset plates. This arrangement, while providing restraint against normal wind loads, allowed free expansion of the girders under temperature variations.

In Spans 2 to 6 the method of erection followed a similar pattern. The four girders were cantilevered out together to a point approximately half way to the next pier. From this point the two inner girders were continued until they were landed on the next pier. This procedure reduced stresses due to moments at the pier from which the span was cantilevered. At the point of change from four to two girders, special cross frames were used to transfer part of the load from the two inner girders to the two outer ones.

At Pier 3 the deflection of the cantilevered ends of the two inner girders relative to their final position reached a maximum of 35 in. At each pier the deflection at the ends of the cantilevered girders was too great to permit erection over the pier without first raising the girder ends by jacking. This was done by attaching a jacking outrigger to the webs, resting on the top flanges of the two inner girder sections adjacent to the pier, as shown in a photograph. A jacking column fabricated from two channels placed back to back, into which a 45-ton Trewhella jack, and a 9 × 9 timber were inserted, was placed on the pier top under each leading end of the outrigger. By raising the timber with the jacks, the inner girders were lifted sufficiently to permit the erection of the pier sections of the two inner girders. The spherical base of each jacking column rested on a steel base plate. The steel cap between the timber and the nose of the outrigger also had a spherical surface. This arrangement permitted unrestrained movement of the propped girder ends in both lateral and longitudinal directions. When not in use, the jacking columns were held in place by a pipe brace attached to the upper end of each column.

After the two inner girder sections were erected over the pier, both girders were lowered onto pairs of temporary roller bearings of $7^1/_2$-in. diameter placed on both inner base plates. To insert the main bearings under the inner girders at this stage would have required jacking the girder up 2 ft 8 in. above the base plates. This would have overstressed the temporary sway frames connecting the outer girders to the inner girders near the center of the span. Supporting the two inner girders on temporary roller bearings 17 in. below the final height gave the best arrangement for the distribution of girder stresses.

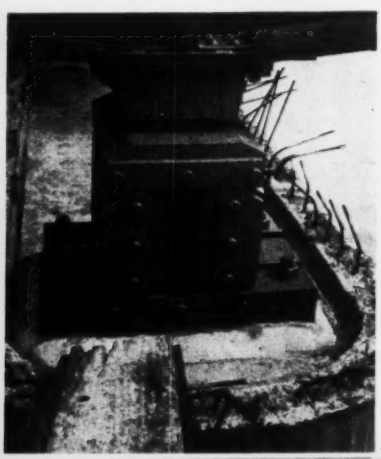
When all four girders at a pier were raised sufficiently to permit insertion of the main bearings, each girder was supported by a 6-in.-dia sand jack with cylindrical ends resting on the end of the main bearing base-plate. These sand jacks were designed to work at much higher pressures than had been used previously, the maximum of 3,000 psi occurring at Pier 4. Besides providing a means for the controlled lowering of the girders on to the main bearings, the jacks could accommodate any longitudinal movements due to temperature variations occurring during the erection of the main bearings.

As erection proceeded, the roadway joists were placed on the upper flanges of the girders behind the winch sled. Membrane curing was employed during the placing of the reinforced concrete roadway deck slab and in the manufacture of the precast concrete footway slabs.

Proportioning of erection gear was based on computed deflections and consequent jacking loads required at the ends of the cantilevered main girders. Observations taken of these end deflections during erection, indicated differences varying from $^1/_2$ to 5 percent from the calculated values.

A feature of the cantilever erection method used was the small amount of erection equipment required. The gear provided was very flexible, being adaptable to varying vertical cantilever deflections and to movements caused by temperature variations and lateral wind forces of any likely intensity.

The bridge was built for the Rockhampton City Council and the Queensland Main Roads Department. Work at the site was directed by K. G. Pennycuick, city engineer of Rockhampton. The Coordinator General's Department, under the direction of the writer, designed the bridge and the erection gear, determined construction procedure, and erected the structural steel work, most of which was fabricated in Brisbane by Evans Deakin & Co., Ltd.



Left:

Girders are lowered onto permanent roller bearings using 6-in.-dia sand jack to control movement.

Right:

Twin-roller bearing supports each girder at each pier, permitting longitudinal movement. Since continuous span of 1,210-ft length is fixed at south abutment, its movement at north abutment may be as much as 9 in.

New 126-mile aqueduct to serve phenomenal growth of Florida Keys

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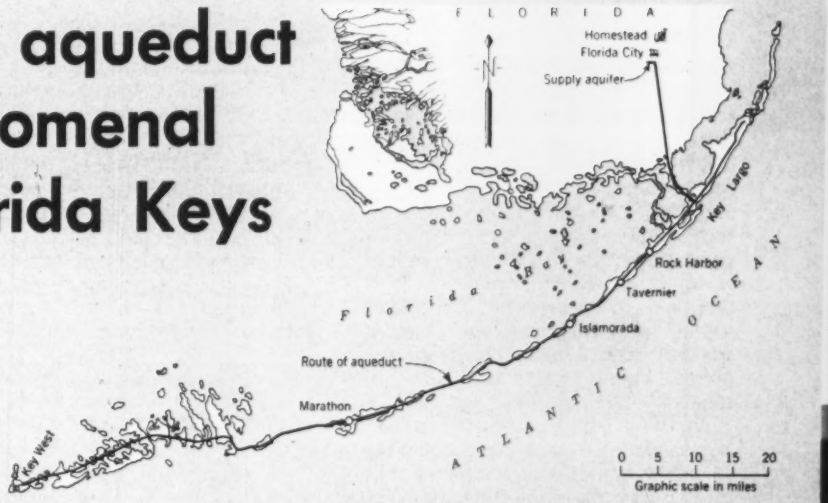

FIG. 1. New Florida Keys Aqueduct will follow route of existing aqueduct and of Overseas Highway from Key Largo to Key West.

Plans and specifications are now being prepared for the new Florida Keys Aqueduct, to extend 126 miles from the source of supply, on the mainland near Florida City, to Key West. Many aspects of the design were routine, or based on experience with the existing aqueduct, but the estimation of future demand up to 1980 required extensive studies taking into consideration the unprecedented recent growth in the Keys area.

Water for the Florida Keys is at present delivered through an aqueduct formerly owned and operated jointly by the U.S. Navy and the Florida Keys Aqueduct Commission, to which the Navy contributed two-thirds of the cost and the Commission one-third. When the contract was entered into, in 1941, it was believed that the 1 mgd allocated to the Commission (out of the 3 mgd total) would be sufficient for civilian needs for a period of 50 years.

The aqueduct was put in service in 1942 and by 1947 the Commission was receiving 1.4 mgd, the maximum that could be spared by the Navy. But the demand for civilian water supply was skyrocketing beyond all expectations, making it necessary to place restrictions on water use. These restrictions became increasingly severe until residents were receiving only a trickle.

In 1952 the Commission decided to improve the situation by providing its own supply. It entered into a new agreement with the Navy whereby it surrendered its rights in the existing aqueduct and the Navy repaid the Commission's share of the original cost. The Commission then entered into a new trust indenture by which it was permitted to improve its water supply system and construct new works. Early in 1952 the Rader Engineering Co. was authorized to prepare an engineering report on a new water supply, delivery aqueduct, and distribution extensions. This report was submitted in July 1952, and plans and specifications are now being prepared for the new Florida Keys Aqueduct (Fig. 1).

East Coast Growth Pattern

The question arises as to why the 1941 estimates for 50 years in the future were exceeded within 5 or 6 years. The development of the east coast of Florida follows a common pattern in which transportation has been one of the controlling factors. The advantages of Florida as a winter resort were recognized at an early date, Ralph Waldo Emerson having spent a winter in St. Augustine in 1827. With the establishment of through railroad connections between northern cities and Jacksonville, that city became an important winter resort. The tourists, however, found that they had escaped only partially from the northern winter, and when railroad transportation was extended to St. Augustine, it became the chief center of the resort trade. The same thing happened when the railroads were successively extended to Daytona Beach, Palm Beach, and Miami.

Although winter temperatures on the Florida Keys are two degrees warmer than in Miami, the Keys area did not experience the growth of its northern neighbors when railroad facilities became available in 1912, or when the county highway was opened in 1926. The lack of an adequate water supply and the ineffectiveness of the transportation facilities were barriers to further southward development.

Key West Expansion in 1942

When the present aqueduct was completed in 1942 there was an immediate increase in the growth of Key West and the Florida Keys, although the country was at war, travel was severely restricted, and construction of new homes and hotels was forbidden except for military purposes. Families of servicemen and others connected with the defense effort crowded into Key West increasing the county's population in 1945 to over 19,000—the peak for the area recorded in 1910. By 1950 the census population had reached 29,957 and the entire area was bursting at the seams with new developments. This growth of approximately 11 percent per year is continuing and is similar to the growth experienced in Dade, Broward and Palm Beach Counties, which has continued without serious interruption for the past forty years.

The Florida Keys area now has excellent highway connections, good commercial airlines and bus service, common carrier freight by truck and an assured supply of good drinking water so that the southward shift of the resort business can be expected to follow the pattern already established in the areas to the north.

Detailed Study for New Aqueduct

Although the engineering problems in connection with the planning of the new aqueduct are similar to those encountered on any long aqueduct for

water supply, the amount of detailed study required varied considerably from that normally to be expected. Investigations leading to the construction of the existing aqueduct had conclusively shown that the water supply must be obtained from the mainland, and the supply works for this aqueduct were located in an aquifer yielding an abundant supply of water of excellent quality. It is proposed to secure the new water supply from this same area, and a tract of land a few miles from the present supply works has been obtained for the purpose.

As the existing aqueduct parallels the single road that runs along the Florida Keys, and the new aqueduct must follow the same route (Fig. 1), experience gained from the existing aqueduct has simplified many of the detailed design problems. Also, experience in operating the present aqueduct, with its multiple pumping stations and distribution problems, has indicated many of the steps to be taken in the design of the new aqueduct. However, the selection of the proper design capacity and the quantities of water to be distributed at various points presented some unusual problems, as did the determination of the probable net revenue to be derived from the system from the time it is put in operation until the design capacity is reached.

Forecasts are usually made by extrapolating data obtained from previous history. In the case of the Florida Keys, opening the overseas highway in 1938 and putting the existing aqueduct in operation in 1942 marked the beginning of a new era. The war, which ended in 1945, delayed the full impact of this era until 1946 or 1947 so that only five or six years of records truly represent the forces responsible for current growth. With such a short history as the basis of forecasts, it has been necessary to analyze all the economic factors carefully to arrive at a reasonable basis for design and to determine probable revenues. An extended survey of Key West, and more particularly of the Florida Keys, was made.

Statistics were obtained on school enrollment, gasoline and electric power consumption, toll highway traffic, population, water consumption, meter installations, building permits and other data and were evaluated in terms of growth of the area. Forecasts of the telephone and electric companies were obtained as well as those of the various chambers of commerce. All these data confirmed the view that 1947 marked the beginning of a new era. Since that time growth has been rapid and steady.

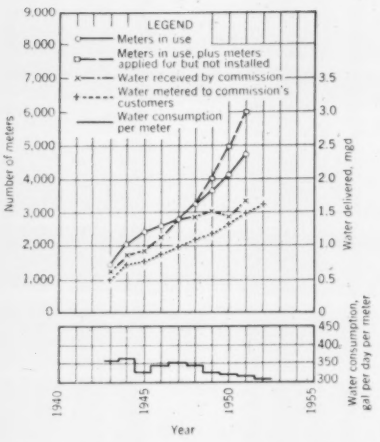
LEGEND
Meters in use
Meters in use, plus meters applied for but not installed
Water received by commission
Water metered to commission's customers
Water consumption per meter
Number of meters
Water delivered, mgd
Water consumption, gal per day per meter
Year

FIG. 2. Meter installations were selected as best indicator of growth in water demand, although they do not truly represent recent increases because of many applications for new connections that have been discouraged or denied. Lower gragh shows water consumption per meter.

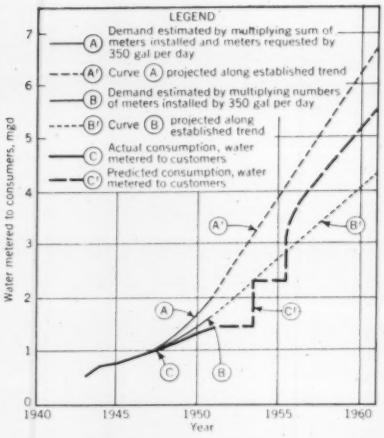
LEGEND
Demand estimated by multiplying sum of meters installed and meters requested by 350 gal per day
Curve A projected along established trend
Demand estimated by multiplying numbers of meters installed by 350 gal per day
Curve B projected along established trend
Actual consumption, water metered to customers
Predicted consumption, water metered to customers
Water metered to consumers, mgd
Year

FIG. 3. Phenomenal growth of Keys area (Monroe County, Fla.) is reflected in estimated metered demand for water 1952–1960. Step in curve *C'* indicates additional 1 mgd to be made available from existing aqueduct in 1953, through improvements now under construction.

The records of school enrollment and population do not show as high rates of growth as other factors, indicating that a substantial part of the growth is due to the tourist industry. Records of water metered to customers show little increase since 1947, whereas the installation of meters has continued at almost a constant rate with the result that the consumption per meter has decreased steadily from 350 gal per meter per day in 1947 to 300 gal per meter per day in 1951. This reduction in metered consumption shows clearly the effect of restrictions on the use of water and the inadequacy of the present supply.

Meter installations were selected as the best indicator of the growth in demand for water resulting from the present development and were used as the basis for projecting this demand into the period following construction of the new aqueduct. Even this indicator does not truly represent the recent increased demand for water on the Keys because of the many applications for new connections which have been denied or discouraged. The installation of meters, water sold to the Commission and its customers, consumption per meter, and the estimated number of meters that would have been installed without restrictions are shown in Fig. 2.

The curve of meter installations has been projected to the year 1960 and converted to metered water consumption using the average consumption of 350 gal per day per meter established before restrictions reduced this figure (Fig. 3, curve *B*). Similarly, the water demand, projected to 1960, which would have occurred had no restrictions been placed on the installation of meters, has been plotted in curve *A* of Fig. 3. Curve *C* represents the estimated consumption of the Commission's customers to 1960. This curve is projected with no increase in consumption until the end of 1953, at which time it is anticipated that an additional 1.0 mgd will be made available from the existing aqueduct as a result of improvements now under construction. The second increase will not come until after the new aqueduct has been put in operation, after which an unlimited supply of water will be available to the Commission's customers, and many delayed projects will come into being.

Although an increase in water consumption from 0.75 mgd in 1945 to an estimated 5.0 mgd in 1960 seems incredible, all indicators bear out this phenomenal growth. In late 1952 the Navy installed a temporary pumping station on the existing aqueduct to relieve conditions. Immediately water consumption by the Commission's customers increased to over 2.0 mgd, still without permitting the restoration of normal pressures in the Key West distribution system, thus indicating that the demand projected in curve *B* of Fig. 3 would have been

equaled or exceeded if water had been available.

The long-range forecast required to determine the design capacity of the new aqueduct could not reasonably be projected from available records. Here the development of other counties in South Florida was used as a guide. The growth of Dade, Broward, Palm Beach and Pinellas Counties was plotted from the time each had a population of 30,000—the 1950 census population of Monroe County. It is reasonable to expect that Monroe County will follow a similar growth pattern since, in each case, the tourist business has been largely responsible for the growth and this is the single most important factor in the present growth of Monroe County. Areas available for development were checked in projecting the population forecast for Monroe County. With the projected population of 102,000 in 1980, the year selected as the design date, and a per capita consumption of 70 gal per day, the new aqueduct should be capable of delivering 7.14 mgd to customers and allowing for line losses should have a design capacity of 8.0 mgd at the supply end.

Before the design could be started it was necessary to determine the distribution of consumption along the aqueduct for each of the critical years throughout the life of the design. Although the growth at Key West has been rapid, and continues to be, there is a limited amount of land available for development and the pattern of development has already been established. Here it was estimated that the water demand would reach about 4.0 mgd by 1980, leaving approximately 4.0 mgd to be distributed along the remaining 100 miles.

While there are several established communities along the Keys, including Marathon, Islamorada, Tavernier and Rock Harbor, the development has not been uniform among these communities nor limited to them. The growth at Marathon has been spectacular with nearly as many dwelling units under construction in 1952 as previously existed in the entire community. Here also plans for extensive additional developments have been made and financed but are being held up because of the inability to get water. Both Islamorada and Tavernier are growing rapidly but there are no large-scale developments nearby to cause them to burst at the seams.

Rock Harbor on lower Key Largo is near some large-scale developments that are getting under way and is expected to grow very rapidly as soon as water becomes available. All of Key Largo is well suited for development; the land is high and lies within an hour's drive of Miami. Also the proposed causeway to be constructed north from Key Largo to Biscayne Key will provide an easy scenic access direct from Miami which will further boost the development of this area. At other points entire keys are being developed as exclusive residential areas which will have a considerable demand for water.

These various growth factors were analyzed and the probable water consumption divided between 12 sections along the Keys for each of the critical years in the design period. The phenomenal growth of the Florida Keys outside of Key West is probably best demonstrated by the records of water consumption, which increased from 50,000 gal per day in 1945 to over 500,000 gal per day in 1952, or a tenfold increase in seven years.

Once the required quantity of water had been determined and the amounts and points of distribution established, the design could proceed. The selection of pipe size was a matter of economics requiring the determination of the proper balance between cost of construction and cost of operation and maintenance. Economy of construction dictates the use of the smallest practical size of pipe whereas economy of operation dictates the largest practical size to keep pumping heads within reasonable limits on the extremely long line (Table I). Also the ability to finance the construction and to pay operation as well as amortization costs entirely from revenue had an important bearing on the design.

Studies were made for a single pumping station and heavy walled pipe, for multiple pumping stations and thin-walled pipe, and for both multiple pumping stations and multiple thin-walled pipe. Under all conditions of operation throughout the design life of the aqueduct, the multiple pumping stations and single thin-walled pipe were found best to meet the limitations of financing, reasonable construction cost and reasonable operation cost. The initial construction would provide for two pumping stations, one at Florida City and one at Islamorada, with additional pumping stations to be constructed when and where needed.

The pipe selected for the aqueduct is steel, lined with bituminous enamel and wrapped with an asphalt-impregnated felt. A $^1/_4$-in. wall thickness was selected for all diameters as best meeting the requirements of transportation, construction, and operation. It is proposed to do all pumping with diesel-engine-driven centrifugal pumps operated at varying speeds, depending on the load. Elevated storage will be provided at each booster station to furnish a constant supply of water to the booster pumps and at the same time provide control for the supply pumps through remote water-level indicators located in the supply station. Water will be distributed at intervals along the Keys from taps, with local distribution systems generally of small-sized pipe. At Key West, water will be received in ground storage reservoirs and repumped for distribution, as at present.

TABLE I. Selection of Aqueduct Sizes

Pump Sta. No.	Distance from Key West, Miles	Av. Rate of Flow at Mid-Point, MGD	Economic Pipe Size, In.	Size Adopted, In.
1	26	7.41	25.0	24
2	105	5.70	22.8	22
3	79	4.66	20.8	22
4	47	3.87	19.0	20
Key West	0			
Average			21.9	22

The magnitude of this project can best be illustrated by the following summary:

Length of new aqueduct	126 miles
Length of 24-in. pipe	21.20 miles
Length of 22-in. pipe	58.10 miles
Length of 20-in. pipe	47.00 miles
Length of aqueduct in trench	61.72 miles
Length of aqueduct on pile support	46.42 miles
Length of aqueduct on bridge or structure	18.14 miles
Design capacity of aqueduct	8 mgd
Design date	1980
Number of pump stations, initial installation	2
Number of pump stations, ultimate	4
Total maximum pumping head, ultimate	1,578 ft
Total installed horsepower, ultimate	4,220 hp
Estimated cost, initial construction	$8,600,000

I wish to express my appreciation to Samuel T. Drew, M. ASCE, Project Engineer, and to the other members of the staff of Rader Engineering Co. who have assisted in the preparation of the data presented in this paper.

(This article is based on the paper by Mr. Greenleaf presented before the Sanitary Engineering Division at the Miami Beach Convention of ASCE. The session was presided over by Lynn Perry, chairman of the Convention's Technical Program.)

Trickling-filter sewage plant built to

As more extensive use is made of radioactive materials, simple and economical disposal of radioactive wastes becomes a problem of increasing importance to research laboratories, industry, the medical profession, the Atomic Energy Commission (AEC), and other governmental agencies. Whether or not the use of these materials will prove financially practicable depends to a great extent upon the cost of waste disposal.

The AEC, realizing this, has financed a number of phases of research in an effort to lower the cost of waste treatment. The findings from these research projects are encouraging, especially in the field of biological treatment. The standard processes for the treatment of domestic sewage show excellent promise of providing a solution, or at least a partial solution, where the amount of radioactivity is not too great. Initial results indicate that both the activated-sludge and the trickling-filter processes for treating domestic sewage are capable of concentrating radioactive particles that are either in suspension or solution.

When, therefore, the Central Facilities Area of the National Reactor Testing Station needed both a modern sewage treatment plant and a waste disposal unit for a "hot" laundry constructed to handle contaminated protective clothing, the Idaho Operations Office of the AEC investigated the suitablility of a biological treatment plant to handle both types of waste simultaneously. Test runs were made in a pilot plant located at the Los Alamos Scientific Laboratory (see Report to Idaho Operations Office, USAEC, May 1952, by John F. Newell, Industrial Waste Branch AEC, Los Alamos) under conditions comparable to those expected in the proposed NRTS (National Reactor Testing Station) plant. Results there were so encouraging that it was decided to proceed with the combination unit at the Central Facilities Area of the NRTS, using a standard trickling filter.

The trickling filter rather than an activated sludge system was indicated, since the former works better with variable flow, and at the Central Facilities Area, flows would be low over weekends and at night.

The engineering firm of Horner and Shifrin, consulting engineers of St. Louis, was engaged to design the plant, using information and data furnished by the Idaho Operations Office. Design followed closely that normally used in standard trickling filter plants but with special provisions for:

1. Precise measurement of flows of both laundry waste and sewage.
2. Close control of flow rates through trickling filter.
3. Recirculation through trickling filter to obtain a constant-flow loading.
4. Varying conditions of operation to find those best suited to the removal of radioactivity.

The accepted design, as now being constructed, is represented in Fig. 1. The domestic sewage and the contaminated laundry waste enter the plant by separate pipelines. Each flow is measured separately on recording flow meters (Kennison nozzles) as it discharges to a common wet well. Pumps force the mixed wastes up to and through bar screens into the primary settling tank, where sludge settles and is later moved on to the digester.

Liquid waste from the primary settling tank flows by gravity to the constant-level orifice box, which is adjustable up to 1,000 gpm, where it is mixed with recirculated sludge from the secondary settling basin and is discharged by gravity at a constant rate to the trickling filter. The orifice box is equipped with calibrated

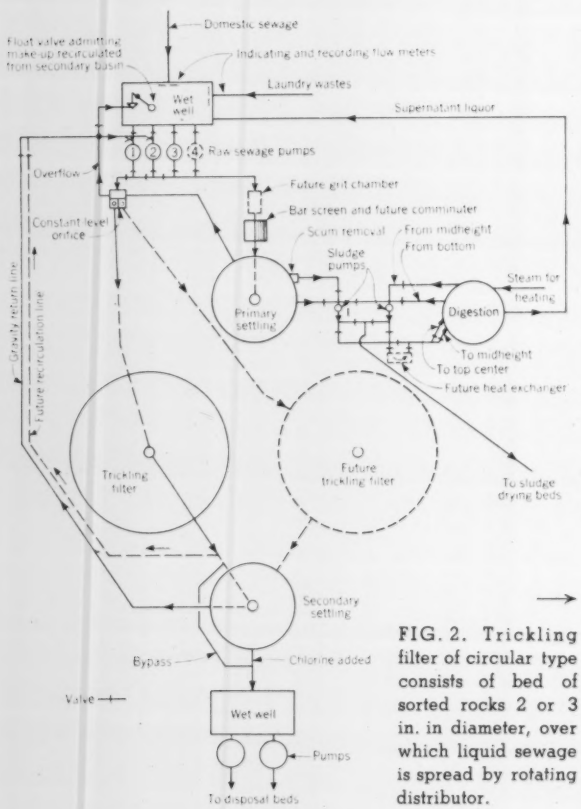

FIG. 1. Flow chart shows arrangement of plant for treatment of both domestic sewage and radioactive laundry waste.

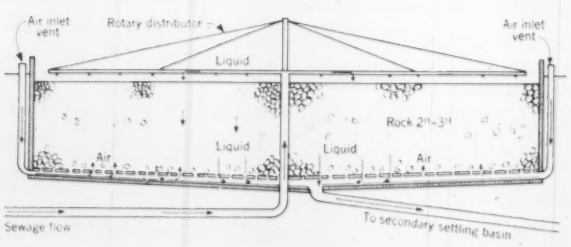

FIG. 2. Trickling filter of circular type consists of bed of sorted rocks 2 or 3 in. in diameter, over which liquid sewage is spread by rotating distributor.

remove radioactive wastes

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Sanitary Engineer
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orifices of various sizes so that the desired rate of flow to the filter can be realized. A constant head on the orifice is maintained by an overflow-weir spillway that returns excess sewage back to the suction side of the raw-sewage pumps or to the wet well.

Trickling filter effluent flows by gravity to the secondary settling basin. The basin effluent is discharged to a wet well that acts as a chlorine contact basin. From here sewage lift pumps discharge the final effluent to a subsurface disposal field.

Settled sludge in the secondary settling basin flows by gravity back either to the influent wet well or to a recirculation pump which lifts it to the constant-level weir box. A float-controlled butterfly valve in the wet well determines which path it takes. This valve passes secondary settled sewage make-up liquid to the wet well during periods of low flow so that the pump will have sufficient sewage to discharge at full capacity to the primary settling basin.

Sludge settling in the primary basin is moved periodically to the digester by a sludge pump controlled by a cycle timer that can be set for any desired pumping cycle. Scum from the scum well of the primary basin is moved by manually valving and operating a sludge pump as often as required. Sludge liquor from the digester is discharged automatically from one of three possible depths, back to the influent wet well. A second sludge pump continuously recirculates the digester contents except in case of pump failure, when sludge removal from the primary basin will take precedent, and recirculation will be discontinued until repairs are made.

The digester is heated by live steam from the laundry boiler plant, and equipped with a solid-type cover without gas recovery. All gas is discharged through a flame trap to the atmosphere. Scum difficulties are expected to be prevented by maintaining the digester full at all times, and by the constant agitation which will exist in the surface exposed in the gas dome, where recirculation flow will be constantly discharging.

Sludge processed in the digester is pumped to drying beds. Valves permit the same sludge pumps to be used for this step. Conventional-type open drying beds will be used, care being taken to return all drainage water from the filters back to the plant's wet well.

Action of Trickling Filter

Liquid sewage is trickled on to the standard trickling filter at rates of 1 to 4 mgd per acre of rock-bed surface (mgad). The name filter is inappropriate and misleading, but has been in use so long that it is nearly impossible to change. The word filter usually connotes removal of particles by a sieving process, whereas a trickling filter is a bed of coarse-grained material where purification is not effected by filtration, but by contact phenomena ascribed to absorption, biological precipitation, fermenting action, and other actions associated with the life activities of micro-organisms.

The functional part of a trickling filter consists of a bed of sorted rocks varying in size from 2 to 3 in. in diameter which are laid in basins varying in depth from 5 to 10 ft (Fig. 2). On the under side of the rocks are underdrains which serve the dual purpose of letting air flow up or down through the rock bed and of collecting the sewage waste as it trickles through the bed. The underdrains discharge the sewage waste into the main drain to the secondary settling basin.

The sewage liquid is spread evenly over the top of the rock bed by rotating distributors for round tanks, and by fixed nozzles for rectangular tanks. The sewage, trickling over and through the rock bed on its way down to the underdrainage collecting system, comes in contact with micro-organisms growing on the rocks. This growth (often spoken of as a slime growth) occurs because of the special environment created for it in the design of the filter and because of the food available in the sewage liquid. This slimy growth is aerobic, that is, it can exist only in an oxygen atmosphere, provided by the air vents leading to the bottom of the rock bed, which enable the filter, literally speaking, to breathe.

These organisms possess the power of first transferring to themselves matter in solution or suspension, abstracting from it food for growth, and finally transferring back to the sewage the end product of decomposition, which is mainly organic matter in suspension that can be removed rather completely by settling basins.

The radioactive particles in solution or suspension that trickle over the filter bed are absorbed, or by other unexplained phenomena taken up, by the slimy growth. As the colonies of micro-organisms grow, they will continuously slough or peel off in various degrees and settle out in the secondary basin. This settled sludge will contain most of the radioactive particles originally found in the waste liquid.

A small amount of sloughing goes on continuously, and an excessive film thickness is generally avoided by this natural unloading. Unloading may be spasmodic at times, during extreme changes in temperature. When such violent unloading takes place, large amounts of suspended matter may be carried through to the secondary settling basin. It is at such times that radioactive particles may be carried through the settling basin into the final disposal stream. To eliminate such excessive carry-over of suspended particles, the secondary settling tank is designed to be larger than that used in standard practice.

Action of the Digester

The principal function of a digester is to produce an environment ideal for the growth of anaerobic bacteria and other micro-organisms, the instruments of digestion. These organisms, in their need for food, break down the complex organic raw sewage sludge pumped into the digester into simple, more stable substances. The product resulting from the breaking down (digestion) of these complex organic sludges is a more or less stable, humus-like solid matter.

During the process of digestion, a change in solid matter takes place and gas is liberated (methane and some carbon dioxide). The sludge solids and sludge liquids segregate, the stable substances settling to the bottom and the sludge liquor (supernatant) rising to the top. The sludge material is reduced to about one-fourth of its original volume. Each

time raw sludge is pumped into the digester, sludge liquor is replaced and overflows back to the plant intake wet well by gravity. The rate of digestion, being a function of time and temperature, normally requires some type of heating. At the NRTS, live steam from the laundry boiler is ejected into the tank. Recirculation of the sludge in the digester tends to maintain a constant temperature throughout the tank. No stirring mechanism is provided.

Because of the relatively small amount of raw sludge digested, the volume of gas produced is minute. It is wasted to the atmosphere, since it is not economical to collect and utilize such a small amount.

The design capacity of the digester is based on 5 cu ft of storage per capita. This is somewhat above normal design standards, but is thought desirable to provide extra storage time so that radioactive decay can proceed further before the sludge is removed to the drying beds.

Continuous Recirculation Provided

The essential difference between the NRTS plant and other conventional trickling filter systems is the utilization of continuous recirculation, with the result that the total filter loading is a little above that provided for in standard design. This variation from conventional procedure is based on research findings at Los Alamos, where tests indicated that while the rate of loading to the filter of the contaminated waste plus domestic sewage gave good results at about 1 mgad, recirculation ratios of 5 to 1 and above gave the most satisfactory overall absorption of radioactivity. That is, the minimum total application rate to the filter should be approximately 6 mgad. High ratios of recirculation appear necessary if effective removal of radioactive contaminants is to be realized. Rates of recirculation of 5, 10, and 15 times the flow-through rates of the plant were tried, but it was found that 5 times produced sufficiently satisfactory results.

Studies further indicated that the return of solids to the trickling filter was beneficial. It must be realized that the accumulation of such solids in a trickling filter eventually would require a portion of them to be disposed of elsewhere, either continuously or intermittently. Because of the special requirements for the treatment of radioactive wastes, flexibility has to be provided in the plant so that recirculation at various rates, intermittent or continuous disposal of secondary settled solids, and other methods, can be accomplished in the operation of the plant. However, too much flexibility, especially in the methods of recirculation, may involve infringement of patent rights. For that reason only one recirculation method is planned, but the design is such that other methods of recirculation can be utilized with only a minimum of cost for alterations.

Retention Tank Omitted

Whether or not to provide a retention tank for the laundry waste was the subject of much study. The fact that the laundry will operate only 8 hours per day and 5 days a week made a retention tank appear mandatory at first. Most of the research carried on had been on the basis of a constant continuous laundry flow to the filters. A retention tank seemed desirable because it would act as a holding basin from which the 8-hour flow could be dispersed to the plant over a 24-hour period. However, it was decided to omit the retention tank for the time being. The tank would not help the inflow over weekends, and since the wet well and primary settling tank would act as a dilution as well as a retention tank and mixing chamber, it was decided to try the treatment without a special retention tank. The design, however, will allow a tank to be added later with a minimum of extra cost. The uncertainties involved, including the capacity of the trickling filter to handle shock loads, made it seem advisable to try out the ability of the plant to concentrate this radioactive waste before spending money for extras.

Action of Pumps

There are three sewage pumps in the NRTS plant, with provisions for adding a fourth (Fig. 1). These pumps are of the non-clog bladeless type, and it will be possible to increase their capacities by impeller change if future loads require it. All pumps will be controlled automatically by float levels in the wet well. In normal operation sewage pump No. 3, of 150-gpm capacity, will be run continuously, admitting make-up water automatically through the float-operated valve in amounts needed to satisfy the capacity of the pump, even though the combined inflow rates of the raw sewage and laundry waste are less than needed.

When the raw sewage and laundry waste flows exceed the capacity of this pump, the make-up valve will close and the flow will be delivered to the primary basin by pump No. 3 plus pump No. 2 (200 gpm), with No. 2 operating intermittently to keep pace with the inflow rate. When the inflow rate drops back below the capacity of pump No. 3, the float-operated valve automatically will come into action to supply make-up water for this pump. This is all accomplished by the contact positions for operation of the pump and the position of the float on the butterfly valve in the wet well. Transfer plugs on the pump controls will make possible the interchanging of any pump to function in any float-switch position.

Sewage pumps No. 1 and No. 2, of 200-gpm capacity each, are so piped and valved that either or both can be used for recirculation. Normally pump No. 1 will be used for this purpose. This pump takes suction from the sludge hopper line in the secondary settling basin and discharges to the constant-level orifice box. The orifice openings normally will be set to take the full flow of the recirculation pump plus the overflow from the primary settling basin when pump No. 3 is in operation. If both sewage pumps are in operation, there will be a gravity return flow from the orifice box to the suction side of the recirculation pump.

By removing a baffle in the orifice box, it will be possible to recirculate to the trickling filter the entire delivery of sewage pump No. 1 (recirculation pump) and sewage pump No. 2 when valved to act as a second recirculation pump. By valving off the line to the make-up (float-operated) valve in the wet well, it is possible to eliminate recirculation to the primary basin and to operate either without recirculation or with recirculation controlled by the capacities of the recirculation pumps or by the orifice control box.

By the proper use of valves it is possible to operate the plant without recirculation in an entirely conventional manner. The make-up float-controlled valve returning recirculated flow to the wet well makes possible the removal of a part of the solids carried with the recirculated flow in the primary basin. Provisions are made so that most units, with the exception of the primary clarifier, can be bypassed should the need arise. The complete plant also can be bypassed through the present existing septic tank, which is being left in place for such an emergency.

Monitoring Radioactivity

The ratio of domestic sewage to laundry waste is estimated to be about 10 to 1, but the amount of radioactive contaminants that will

be present in the laundry waste is not known accurately. The amount of contamination reaching the treatment plant from the laundry will be partially controlled at the laundry by monitoring the waste as it leaves, and by discarding garments found to be grossly or dangerously contaminated. Contaminats are expected to be principally mixed fission products.

There is a probability that the digested sludge will contain so much radioactivity that special handling may be required. Provisions will be made for monitoring the laundry waste inlet line and also the final basin effluent line. Monitoring of the digested sludge will be required each time it is withdrawn for drying.

Special operating records are planned, to indicate the percentage removal of all radioactivity. Since this will be the first plant designed for the removal of radioactive contaminants along with the treatment of domestic sewage, all operations will be supervised closely and records maintained to determine the future of such combined treatment plants.

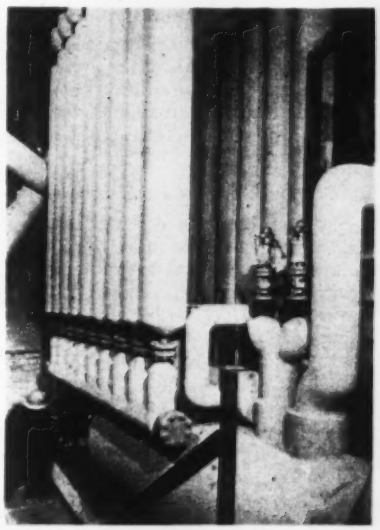
The operating results obtained from this plant will be of special interest, since it is the first plant of its kind, other than research pilot plants, to utilize the conventional biological methods of domestic sewage treatment for the concentration and removal of radioactivity in waste liquids. Its operation may indicate a relatively simple and cheap method for the disposal of these wastes.

AEC Announces Success of Its Breeder Reactor

Former Chairman Gordon Dean, of the Atomic Energy Commission, reported in June a revolutionary development in its program. The experimental breeder reactor at the Commission's National Reactor Testing Station in Idaho is "breeding" new fuel successfully, that is, it is converting nonfissionable material into fissionable material as rapidly as the nuclear fuel is being consumed. It is theoretically possible to manufacture more fuel than is consumed. It was this reactor that was the first known to generate electric power when, on December 20, 1951, all electrical power demands of the reactor and the building, about 170 kw, were supplied from atomic energy.

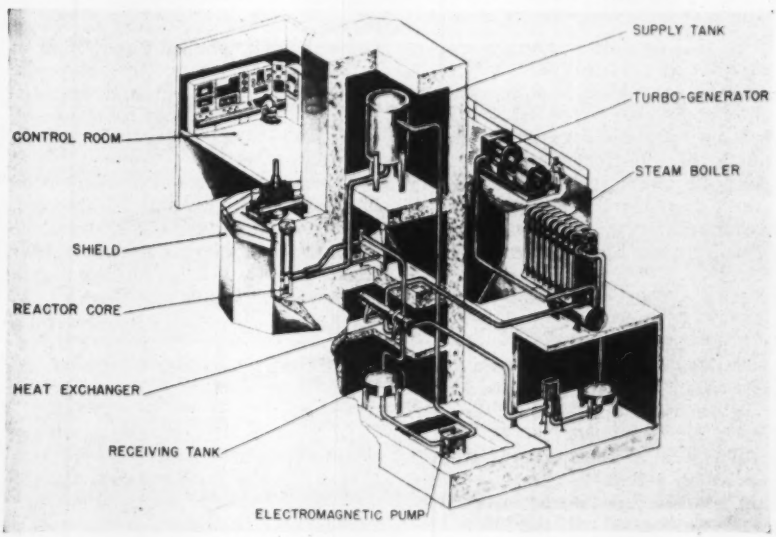
Some conceptions of the experimental breeder reactor are shown in the accompanying illustrations released by the Commission. Heat is extracted from the reactor by liquid metal alloy of sodium and potassium (Na-K), circulated at high temperature under radioactive conditions to a heat exchanger. Heat is removed from the exchanger by another circuit hot liquid Na-K alloy. This secondary circuit, which is not radioactive, flows to a steam boiler and superheater. Electricity is generated by a conventional steam-turbine-driven generator operating with superheated steam at 550° F and 400 psi. Generator capacity is 250 kw. More details of this plant are to be found in an article in the September 1952 issue of *Nucleonics* by W. H. Zinn, Director, Argonne National Laboratory, Chicago, Ill.

Gordon Dean, who resigned from the Commission on July 1, has been succeeded as chairman of the AEC by Lewis L. Strauss, New York financier and former member of the Commission, whose reappointment to the Commission was confirmed by the Senate on June 27.

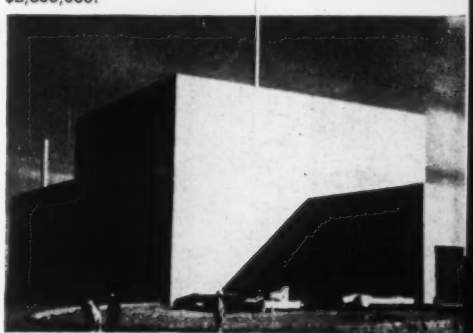


Steam boiler was developed by Argonne National Laboratory for experimental breeder reactor. Its unique design prevents mixing of steam with Na-K coolant, with which it would react violently.

Cut-away view shows experimental breeder reactor and associated equipment.



Experimental breeder reactor at AEC National Reactor Testing Station in Idaho is housed in this building. Cost of plant, begun in November 1949, is stated to be $2,800,000.



FIELD HINTS

Self-reading level rod easily reconditioned

DOUGLAS L. PARKHURST, Chief, Instrument Division, U. S. Coast and Geodetic Survey

A self-reading level rod of unusual accuracy, which was originally designed and built by the Bureau of the U.S. Coast & Geodetic Survey, has recently been entirely redesigned. This has been done with a view to greater ease in manufacturing and, more particularly, to reduce the frequency and cost of reconditioning after field use.

Scale in Black and White Checkerwork

The rod consists essentially of a scale which is a little more than three meters in length and is graduated in black and white checkerwork with markings 1 cm wide (0.393 in.). Each graduation must be correctly positioned from the bottom of the rod to within ± 0.1 mm, or 0.004 in. Furthermore, as the rods are used in pairs, mates are required to be identical to within 0.1 mm.

To facilitate reading the rod, decimeter intervals are colored alternately black and white and are appropriately numbered at the sides of the graduations. The midpoint, or 5-cm interval, is marked by a cross. The reverse side of the rod has a scale in feet, 10ths and 100ths, which serves as a rough check for gross errors against the accurate reading of the rod face.

Mechanically, the rod is built with a 1-in.-wide strip of Invar with a low temperature coefficient, which carries the checkered graduations; a wooden backing piece to support the Invar and identification markings; and a hardened steel footpiece to which both strip and backing are rigidly attached.

The Invar strip is held within metal guides set into the wood, so that it is free to move lengthwise. A spring and plunger arrangement at the top of the rod holds the strip taut.

Painting of Graduations Simplified

On the new rod, the checkered graduations are painted through a meter-long mask made of Invar of the same composition as the strip, so that no trouble is experienced because of ordinary temperature changes. Only five settings are required to paint the entire scale. A harder and more tenacious paint is used than was formerly employed so that the graduations have a longer life.

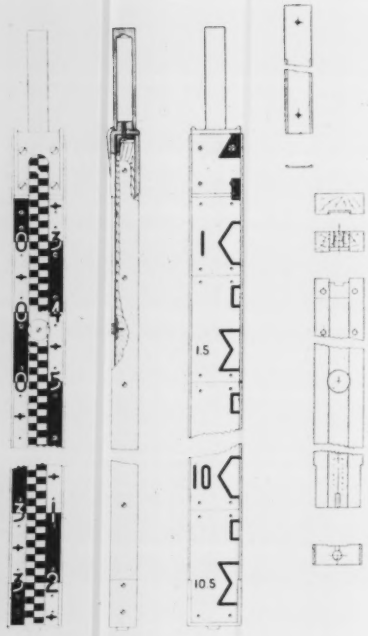
The identification markings and the scale on the reverse side of the rod are applied in an entirely new manner. They are made up in sections of sheet bakelite engraving stock. Two kinds are used, one having black exterior surfaces, with a white layer in between; and the other having white surfaces, with a black interior. The markings are formed by cutting through the outer layer in an engraving machine, thus reproducing a suitable master character. The units are then fastened to the wooden part of the rod with wood screws. The new backing is somewhat thicker so that breakage should be materially reduced if not eliminated.

Worn Footpiece Can Be Refinished

The new footpiece is composed of harder material and has been made smaller and lighter by boring out the stem. The present design permits the introduction of shims at the point where the strip and footpiece join. These additions, with special tooling, permit a worn footpiece to be refinished. The resulting reduction in length can be measured by means of a micrometer microscope and compensated for by shimming, so that rod calibration and mating will remain constant.

The sides of the rod are protected by a special magnesium extrusion, which forms rounded edges above the markings and also covers their outer edges. The rod is also fitted with a thermometer which reads from −15 deg to +55 deg C. All other components have been standardized to insure interchangeability, and special tools have been constructed where necessary.

As a result of these changes in the original design, repairing and reconditioning can be done without the extensive use of hand work, as has previously been the case.



Self-reading level rod has 1-in.-wide strip of Invar (right) with black and white checked scale in centimeters. Each graduation must be correct to within ±0.1 m. Spring and plunger arrangement at top of rod holds movable strip taut. Reverse side of rod (left), which supports Invar, is made of wood and has scale in feet, 10ths and 100ths.

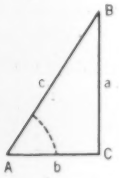
Angles laid out in field with steel tape alone

MARVIN GATES, J. M. ASCE, Field Engineer, Construction Department, New York Central Railroad, Syracuse, N.Y

Frequently the surveyor has occasion to lay out an angle on the ground when a transit is not at hand. A method that I have found to be simple and accurate to within 1 minute requires no equipment except a steel tape 100 ft long.

This method utilizes the following general equations:

In right triangle ACB,



By definition,

$$a + b + c = K \text{ (perimeter)} \quad . \quad . \quad (1)$$

By definition,

$$\left.\begin{aligned} a &= c \sin A \\ b &= c \cos A \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Substituting Eq. 2 in Eq. 1, and solving for a, b, and c,

$$a = \frac{K}{1 + \cot A + \csc A}$$

$$b = \frac{K}{1 + \tan A + \sec A}$$

$$c = \frac{K}{1 + \sin A + \cos A}$$

Problem: Given a steel tape 100 ft long, to lay out an angle of 23° 06′.

Solution:

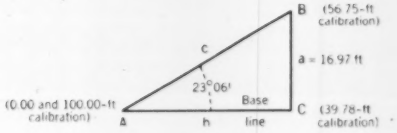
$$a = \frac{100.00}{1 + 2.3445 + 2.5488} = 16.97$$

$$b = \frac{100.00}{1 + 0.42654 + 1.0872} = 39.78$$

$$56.75$$

$$c = \frac{100.00}{1 + 0.39234 + 0.91982} = 43.25$$

(check) 100.00



Field Procedure Described

1. The 0.00 and 100.00-ft calibrations are held on point A of the base line AC.
2. At point C, the tape is either held or guided around by a nail.
3. The engineer at B pulls the tape taut with a nail or pin at the 56.75-ft calibration. Keeping the tape horizontal, he bobs down to accurately locate point B.

ENGINEERS' NOTEBOOK

Backwater profiles solved by Escoffier-Raytchine-Chatelain method

JOHN R. STIPP, Engineer, Illinois Division of Waterways, Springfield, Ill.

A convenient method of determining water-surface profiles in cases where both the discharge and the starting elevation are indeterminate, appears to have been developed independently in this country and in France. An early form was presented by Francis F. Escoffier in *Engineering News-Record* (June 27, 1946). He later revised his method to include the effects of changes in velocity head, and presented the revision in a lecture before the Engineers' Club of Mobile on December 16, 1949. The subject was treated further by N. Raytchine and P. Chatelain in the periodical, *La Houille Blanche* (May–June 1950). To publicize the method in this country was a particular wish of the late Harry W. Hill, Principal Engineer of the Illinois Division of Waterways, who encouraged me to prepare this article. Since one set of curves will serve for different discharges, the method is somewhat more flexible than that presented by Irving Joseph, A. M. ASCE, in CIVIL ENGINEERING (January 1952).

The development of the Escoffier-Raytchine-Chatelain method is as fol-

lows: In Fig. 1, which shows in side elevation a situation of steady flow, the heavy line *O-O* represents datum, the hachured line the channel bottom, the light solid line the water surface, and the dashed line the total energy line. Using Leach's conveyance term, Kd, $S = \frac{Q^2}{Kd^2}$, where S is the slope of the total energy line; Kd can be evaluated by any of the variations of the Chezy formula (for example, by Manning, $Kd = \frac{1.486}{n} AR^{2/3}$). The elevation of the point p may be expressed in terms of Section 1 and Section 2 as follows:

$$Z_2 + y_2 + \frac{V_2^2}{2g} - \frac{L}{2}\frac{Q^2}{Kd_2^2} = Z_1 + y_1 + \frac{V_1^2}{2g} + \frac{L}{2}\frac{Q^2}{Kd_1^2}$$

Substituting Q/A for V and transposing,

$$Z_2 + y_2 - Z_1 - y_1 = \frac{Q^2}{2gA_1^2} + \frac{L}{2}\frac{Q^2}{Kd_1^2} - \frac{Q^2}{2gA_2^2} + \frac{L}{2}\frac{Q^2}{Kd_2^2}$$

Factoring out Q^2 and arranging the terms to correspond to the graphic solution,

$$(Z_2 + y_2) - (Z_1 + y_1) = -Q^2\left[\left(\frac{1}{2gA_2^2} - \frac{L}{2Kd_2^2}\right) - \left(\frac{1}{2gA_1^2} + \frac{L}{2Kd_1^2}\right)\right]$$

The quantities,

$$\frac{1}{2gA_1^2} + \frac{L}{2Kd_1^2} \text{ and } \frac{1}{2gA_2^2} - \frac{L}{2Kd_2^2},$$

here designated as F' and F'', respectively, are functions of the depth and may be plotted for each section used in the step computations (Fig. 2). The value of L may be varied as desired for the several reaches to be used in the computation.

To determine the water-surface profile, the designer starts, for a channel of mild slope, with the most downstream section, and from the point A of known elevation on the F' curve, draws a line at a slope of $-Q^2$ to the F'' curve of the next section upstream. The intersection will be at the elevation of the water surface at this section. To proceed to the third section, a horizontal line is drawn from the last-mentioned intersection to point B on the F' curve for the second section, and a line of slope $-Q^2$ is again drawn, from point B to the F'' curve for the third cross-section. Elevations at following sections are determined by a continuation of the process.

Once the diagram is set up, a profile for any given discharge can be computed very rapidly. It is only necessary to draw the lines at a slope equal to minus the square of the discharge.

The earlier method, presented by Escoffier in June 1946, is essentially the same as that described above except that the velocity-head terms, $1/(2gA_1^2)$ and $1/(2gA_2^2)$, were omitted, and an approximate equation resulted:

$$(Z_2 + y_2) - (Z_1 + y_1) = \frac{Q^2L}{2}(P_2 + P_1)$$

where $1/Kd^2$ was expressed as P.

The effects of a velocity distribution coefficient and of eddy losses may be readily included if desired. The velocity distribution coefficient is introduced by merely substituting it for unity in the numerator of $1/(2gA^2)$. Eddy losses, which occur in decelerating flow, are usually computed as some fraction of the loss of velocity head; to allow for them, the term $1/(2gA^2)$ is multiplied by the complement of this fraction. Thus, if p is the portion of the change in velocity head in an expanding channel which is assumed to be lost, and if a velocity distribution coefficient of C_m is used, the term $1/(2gA^2)$ is replaced by $\frac{C_m(1-p)}{2gA^2}$.

The dimension of the abscissa of Fig. 2 is sec ^{2}/ft^5. When a difference in abscissa is multiplied by a slope of $-Q^2$ (dimension of ft ^{6}/sec^2), the resulting ordinate has the desired linear dimension, in feet. If consistent units of length and time are employed throughout, the slope, $-Q^2$, as computed in a strictly numerical fashion, will be correct.

Escoffier has also pointed out, in a discussion (*La Houille Blanche*, May-June, 1951) of Raytchine's and Chatelain's article, some interesting properties of these curves and has introduced a third function, $F = 1/(2gA^2)$ (Fig. 3). A line of slope $-Q^2$ through this curve intersects it at the two alternate depths, y_U and y_L; at these depths the total energy is OH. For the energy to be at a minimum, OH_c, the line must be tangent to the curve; this represents critical flow. This property is often useful in starting the computation of a water-surface profile.

Whether a reach has mild-slope or steep-slope characteristics can be determined by the relative positions of the F' and F'' curves. If the F' curve at the downstream section of a reach lies entirely above or to the right of the F'' curve for the upstream section, as shown in Fig. 2, the reach has mild-slope characteristics. If the positions are reversed, the reach has steep-slope characteristics. If the two curves coincide (an unusual situation), the reach has critical-slope characteristics. Also, the curves may intersect, in which case the reach has one type of characteristics for stages above the point of intersection and the other type for stages below.

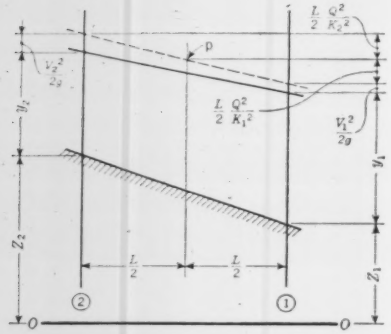


Fig. 1. Situation of steady flow is shown in side elevation. Heavy line O-O represents datum; hachured line, channel bottom; light solid line, water surface; and dashed line, total energy line.

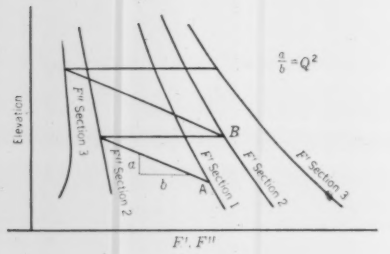


Fig. 2. F' and F'', functions of depth, are plotted for each section used in step computations.

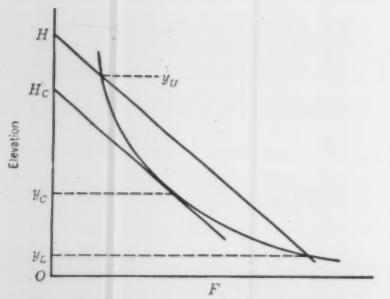


Fig. 3. Third function of F introduced by Escoffier is $F = 1/(2gA^2)$.

Pumping stations for drainage areas designed graphically

OLIVER J. PARSONS

Mechanical Engineer, Robert & Co. Assocs., Inc., Atlanta, Ga.

Determining the proper ratios between rainfall, storage, pumping rate, pump horsepower, and storage-tank depth for an underpass or for tunnel drainage areas can be a time-consuming task if attempted numerically. For this reason the graphical procedure here presented was developed and has proved to be a rapid method of designing pumping stations for drainage areas.

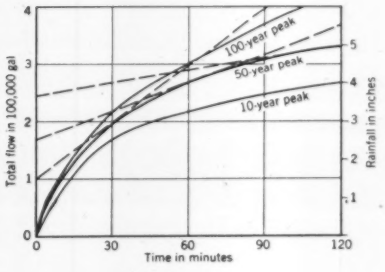
The accompanying curves illustrate the design of a railroad underpass with an effective runoff area of 107,000 sq ft in the vicinity of Houston, Tex. The underpass pumping station is designed to remove enough water to prevent a traffic stoppage from occurring more often than once in 50 years.

The time curves for peak runoffs shown in Fig. 1 were obtained from *Rainfall-Intensity Frequency Data*, published by the U.S. Department of Agriculture. Tangent lines drawn to the 50-year-peak curve are used to plot the flow curve of Fig. 2. The slope of a tangent line in Fig. 1 is the pump capacity required to prevent any flooding with a storage capacity equal to the total-flow axis intercept.

The cost curve of Fig. 2 is obtained by estimating the annual cost for pumping and storage for various points on the flow curve. The net storage volume required is the gross storage shown on the curves less the 40,000 gal of allowable road storage; that is, 40,000 gal in the road will not stop traffic. The only annual cost considered, other than depreciation and interest on the capital investment, is the electrical power cost. For this type of pumping load it is normally better to consider the kilovolt-ampere demand cost rather than the kilowatt-hour consumption. The minimum point of the cost curve gives the optimum pump capacity of 204,000 gal per hour, or 3,400 gal per min, and the gross storage required of 93,000 gal.

Because of the type of maintenance and the load, two similar pumps for the load and another pump as an operating auxiliary are used. All the pumps discharge into a single conduit.

Curves for the piping system characteristics and pump characteristics are shown in Fig. 3. Level control distances B and C may be varied, but if they are decreased, the pump operating head which is set by the curve for "3 pumps, old pipe, 17-ft suction" will remain constant. If B or C is increased, the pump size must be increased to give the required capacity



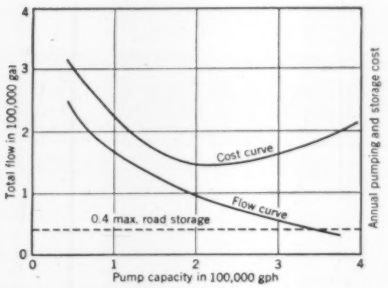
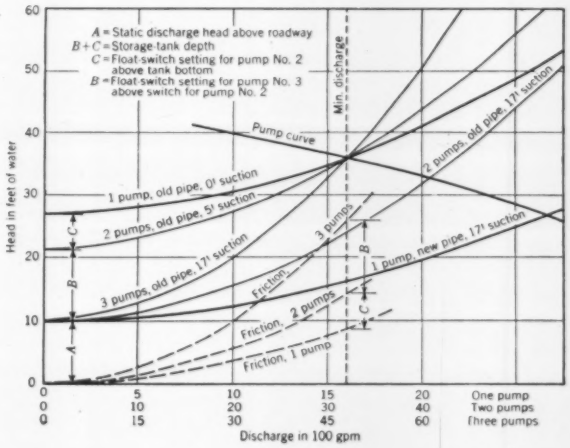


FIG. 2. Flow curve is plotted from tangent lines drawn to 50-year-peak curve of Fig. 1. Cost curve is obtained by estimating annual cost for pumping and storage for various points on flow curve.

FIG. 1. Time curves for peak runoffs were obtained from *Rainfall-Intensity Frequency Data*, published by U.S. Department of Agriculture.

FIG. 3. Curves show piping-system and pump characteristics. Curve for "2 pumps, old pipe, 17-ft suction" is added to show that final pump capacity exceeds original design.


A = Static discharge head above roadway
B + C = Storage-tank depth
C = Float-switch setting for pump No. 2 above tank bottom
B = Float-switch setting for pump No. 3 above switch for pump No. 2
Min. discharge
Pump curve
1 pump, old pipe, 0' suction
2 pumps, old pipe, 5' suction
3 pumps, old pipe, 17' suction
2 pumps, old pipe, 17' suction
1 pump, new pipe, 17' suction
Friction, 3 pumps
Friction, 2 pumps
Friction, 1 pump
Head in feet of water
Discharge in 100 gpm
One pump
Two pumps
Three pumps

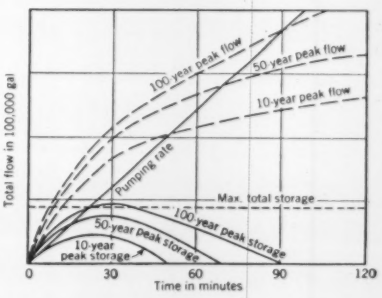


FIG. 4. Final system results are based on curve for "2 pumps, old pipe, 17-ft suction" in Fig. 3. Distances from pumping-rate curve to peak curves give storage curves.

at the increased operating head. Distances B and C are determined by the piping friction. The friction curves are shown dashed in Fig. 3.

In order to specify the pump required for the service, the full operating range is necessary. The maximum delivery for any one pump is shown by the curve for "1 pump, new pipe, 17-ft suction." This curve normally determines the maximum pump horsepower. This condition of operation will never be reached unless pump No. 2 should fail.

The curve for "2 pumps, old pipe, 17-ft suction" is added to show that the final pump capacity exceeds the original design requirement. This new increased pumping rate is used to show the final system results in Fig. 4.

The curves of Fig. 4 are similar to those of Fig. 1 except that the new curve for the pumping rate is added. The distances from the pumping-rate curve to the peak curves give the storage curves.

As an added refinement in design, a curve for storage versus water level can be drawn. From this curve, using the 100-year storage, the maximum flood level above the road can be determined. The pump motors should be located above this flood level.

As can be seen from the design work, the graphical method gives the engineer a visual picture of the system performance. The design can be easily modified without the necessity of repeating time-consuming calculations.

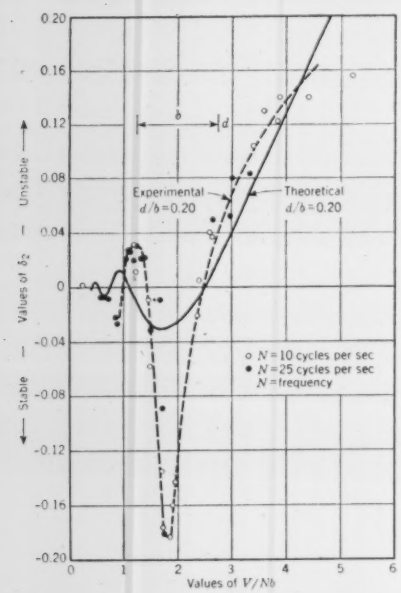


FIG. 1. Torsional instability graph for an H-section (d/b = 0.20) shows good agreement between theoretical and test results.

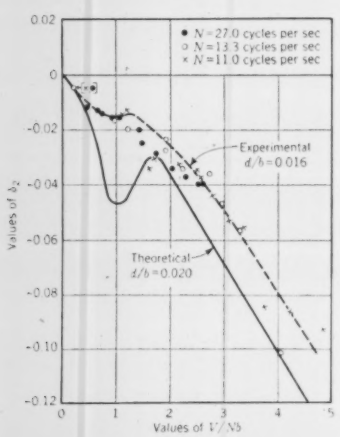


FIG. 2. Torsional stability graph for a flat plate shows general agreement in form of curve although plates compared were not exactly the same.

Tests confirm Steinman theory of bridge oscillations

F. J. MAHER, Professor of Applied Mechanics, Virginia Polytechnic Institute, Blacksburg, Va.

Two torsional response curves for freely oscillating, elastically supported models are here presented. The first, Fig. 1, is for an H-section in which d/b= 0.20. The second, Fig. 2, is for a flat plate.

The tests on which these graphs are based were carried out in an effort to provide some general confirmation of the theory of analysis of aerodynamic instability of suspension bridge decks presented by D. B. Steinman, M. ASCE, in his paper, "Aerodynamic Theory of Bridge Oscillations," which won the Norman Medal and was published in ASCE TRANSACTIONS, Vol. 115, 1950. His analysis utilized the static lift, drag, moment and pressure distribution tests on straight and curved models of a bridge deck. He was able to deduce the instability response graphs for torsional and vertical motion of a flat plate and a girder section of the approximate proportions of the original Tacoma Narrows section.

At the time Dr. Steinman's paper was presented, basic dynamic test data were virtually non-existent, and a good check of the theory was difficult to obtain. The two series of tests here reported are of interest in this connection. Although some discrepancies exist, it is felt that the test results provide additional confirmation of the general validity of the theory which was proposed by Dr. Steinman.

The experimental and theoretical results for an H-section (d/b= 0.20) are compared in Fig. 1. The agreement is generally good, particularly in the highest instability region and at the last critical point (V/Nb = 2.5), in which V=velocity and N=frequency. The discrepancy in the lower regions may be partly explained by two major points of difference in theory and test. In the theory, the damping rate as measured by the logarithmic decrement δ is based on the linear theory of viscous damping and on the values of slope at the origin of the static curves. In the tests, it was necessary in the stability regions to deflect the model through some initial angle and measure the damping over some finite decrement (in this case from 1 deg to 0.5 deg, approximately).

In the regions of instability, the model was first held in a position of equilibrium. After release, the decrement was based on the increase of amplitude from 0.5 deg to 1.0 deg approximately. The records obtained were actually a composite of viscous, internal and perhaps some Coulomb damping.

Separation of aerodynamic from total damping is generally obtained by direct subtraction. While this is general practice, it may be open to question when the non-linear components of damping represent a large part of the total. Experimental results have shown some indication that the value of δ varies with amplitude. (At a later date, it is intended to study the effect of amplitude and initial angle of attack on the instability response). Another possible reason for the discrepancy is the fact that the lower values of V/Nb were run at a much smaller value of Reynold's number than were the

static tests on which the theory is based.

The correlation between the results on two flat plates is shown in Fig. 2. Unfortunately, the two plates were not exactly the same, so that the results are comparable only on the basis of being members of the same family of curves. On that basis, however, the agreement is good.

In both figures, the ordinates of the theoretical curves have been increased to compensate for differences in air density, weight of deck, width of deck, and radius of gyration about the center of rotation. The curves drawn through the field of experimental points are only approximately fitted to the data.

All values shown are corrected for structural damping. The structural damping was obtained in the following fashion. The model was removed and a cylindrical bar was placed between the bearing supports. A small rod normal to the cylinder carried adjustable weights to produce the same moment of inertia and the same frequency as the model system. The inertia system was then oscillated and the decay measured as in the model tests. The method eliminated any effects of frequency and amplitude, and although it did not eliminate possible atmospheric damping of the inertia bar and weights, it was felt that the procedure was the best obtainable under the circumstances.

The author wishes to acknowledge the aid of the Research Corporation of New York in making the test work possible.

THE READERS WRITE

Continuous Footings Often Wrongly Designed

TO THE EDITOR: In his article, "Grid-Type Footings Support California State Capitol Extension," in the June issue, Frank A. Johnson states:

"In these continuous footings the usual problem of reconciling the upward reactions due to soil pressure with the support offered by the column loads was encountered. In extreme cases the widths of the footings were varied, and reasonable agreement between column load and soil reaction was achieved. The computations were of necessity tedious and involved a great deal of cut and try."

It is not my intention to reflect on the design reported in the above-mentioned article, especially since it is not evident from the cited data whether or not the deflections of the foundation were taken into account. However, in my own experience I have repeatedly come up against attempts by some designers to follow a procedure similar to the one indicated above. Briefly, this procedure is to regard the continuous footing as an inverted continuous beam uniformly loaded with soil pressure and supported by the columns. The moments are computed as for a continuous beam on level supports.

The resulting reactions are then compared with the actual column loads. Exact agreement being likely only by the sheerest of coincidences, if the discrepancy in individual columns is of the order 10, 20, or even 30 percent, it is often disregarded. Only if the divergence becomes very large is the designer apt to become perturbed, in which case he would attempt to achieve a semblance of agreement by some such means as varying the widths of the footings or the soil pressure in individual spans.

The error underlying this procedure should be obvious when it is realized that continuous footings on yielding soil do settle and deflect varying amounts under the different columns. Thus the "inverted continuous beam" may have any set of reactions consistent with the laws of statics, and not necessarily that particular set which is associated with unyielding supports.

The real indeterminate feature in the design of such foundations is the distribution of soil pressure, but this is in practically all cases assumed as uniform anyway. Once this assumption has been made, the computation of the moments in the footing becomes a matter of simple statics. The moment at any section of the footing is equal to the algebraic sum of the moments of all the external forces to one side of that section, the soil pressures acting upward and the column loads acting downward. These moments, and only these, represent the true state of stress within the footing, subject to the one qualification that the assumption as to the distribution of soil pressure is reasonably true to fact.

The moment diagram for a uniformly loaded continuous beam on level supports generally looks like the accompanying Fig. 1 (*a*), with easy positive and negative moments alternating in every span. However, if the interior column loads exceed the theoretical reactions of such a beam by even a moderate amount, the true moment diagram will resemble Fig. 1 (*b*). It is not unusual for the actual maximum moments, shown in (*b*), to be 10 or more times as large as the theoretical, shown in (*a*), for the same beam and loading.

Combined footings, as well as mat- and grid-type foundations are usually resorted to in order to minimize differential settlements on cohesive soil strata. The assumption of uniform soil pressure itself must be used with caution in such foundations. It is well known that extensive foundations on such soils tend to "dish" in the center, which is saying that the "foundation modulus" varies for different areas under the structure, being lower at the center and increasing towards the edges.

To reduce the amount of "dishing" to a tolerable minimum it is necessary to load the interior portions of such a foundation to a lower intensity of pressure than those at the perimeter. Since the distribution of the load in many structures is just the reverse of that requirement, the continuous elements of the foundation are called upon to transfer, by means of beam action, a good part of the building load from the middle to the outlying parts of the supporting soil. When allowance is made for this condition, the maximum moments in the footing are likely to be half again as large as those for uniform soil pressure. If a continuous foundation is to be capable of performing its function of reducing differential settlements, it must be designed for the large moments indicated above to give it the necessary rigidity. Otherwise it will be very flexible and quite incapable of serving its intended purpose.

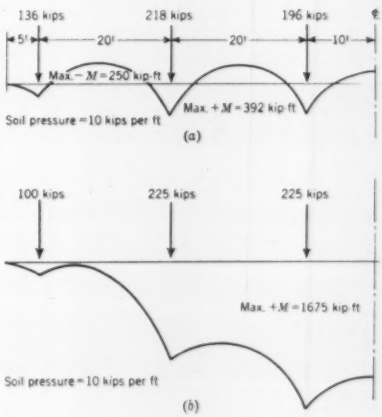


FIG. 1. Moment diagram for uniformly loaded continuous beam on level supports, which typically appears as in *(a)*, may actually resemble *(b)* if interior column loads exceed theoretical reactions of such a beam by even a moderate amount.

ABRAHAM I. GARTNER, A.M. ASCE
Contract Supervisor
Foster-Wheeler Corp.
New York, N.Y.

SOCIETY NEWS

Annual Convention of ASCE to Make Most of New York Location

An extensive technical program, inspection of facilities at the Fairless Works of U.S. Steel, numerous social events and a post-convention inspection of Kindley Air Force Base in Bermuda are some of the highlights of the program for the 1953 Annual Convention of ASCE. The Statler Hotel in New York will be headquarters for the Convention, to be held October 19–23—New York's most reliably good weather period of the year.

Mass Transportation Major Theme

Several of the Technical Divisions are cooperating in presenting for study various aspects of the major technical program theme, mass transportation. Altogether some 30 sessions are being scheduled, with recent developments in all fields of civil engineering to be represented. The Divisions are utilizing the New York locale advantageously in scheduling inspection trips to works in progress, with all joining in an entire day devoted to a trip over the New Jersey Turnpike to the Fairless Works of U.S. Steel, near Morrisville, Pa. Because of the wide variety of objectives of interest on this tour, several specialty groups will be formed for inspection of facilities of their own major concern.

Committee in charge of New York Convention of ASCE includes (seated, left to right) Don P. Reynolds, Emil A. Verpillot, Jewell M. Garrelts, Mrs. Raymond L. Brandes, and Raymond L. Brandes, chairman. Standing are S. D. Stickel, John F. Molloy, William S. LaLonde, Robert H. Dodds, Roger H. Gilman, Thomas J. Fratar, Walter S. Douglas, and John R. Zehner. Upper view shows headquarters for post-convention tour in Bermuda—the beautiful waterfront hotel, the Princess.

New York Best in October

Because many have an eye to the weather when they plan attendance at an ASCE meeting, the Convention takes advantage of the best time of the year in New York. Mild, sunny days will favor inspection trips, good transportation connections (and shopping expeditions for the wives, too, you can be sure). The latter factor affected the selection of the headquarters hotel.

To accommodate the expansive program of events and the large attendance of a convention as well as for convenience in shopping, the commodious Hotel Statler will again house the New York Convention. Located on Seventh Avenue at 33rd Street, the Statler is directly opposite the Pennsylvania Station with underground corridors connecting the two. In addition to customary direct service to air, rail and bus terminals, the hotel has its own subway station in the basement, and complete parking service for those driving to the Convention. Shops and services of every kind are in, or connected directly to, this convention-designed hotel.

Offers Variety of Social Events

For the entire week of the Convention, nearly continuous entertainment has been planned. The annual dinner-dance—a formal party with reception, entertainment, banquet and dancing, scheduled for October 21—will be a highlight. Another evening will feature a smoker for the men and special entertainment for the women.

An outstanding international figure will be keynote speaker at the Membership Luncheon, another annual event. On other days luncheons, cocktail parties and dinners will be sponsored by Technical Divisions, alumni groups, and related organizations. One luncheon being arranged by the Highway Division will open a series of sessions on the New York State Thruway. Another, sponsored by the Construction Division, will feature construction financing. Similar functions are being scheduled by the Sanitary Engineering, Engineering Mechanics and Soil Mechanics and Foundations Divisions.

Special attention has been given to entertainment for the many wives accompanying their husbands to the Convention. Several parties, excursions and fashion shows are scheduled. As the entertainment capital, New York has a vast variety of features, upon which the Ladies Committee has drawn heavily to provide a program of interest to all.

Air Base Inspection in Bermuda

An unusual opportunity to visit a major offshore installation is offered in a post-convention inspection tour of Kindley Air Force Base, Bermuda. This tour will leave New York by air on Saturday immediately following the convention events in New York, and will combine a brief autumn holiday with the inspection of engineered facilities.

New projects at the Kindley base include a power house, a sea water distillation plant, a new sea wall, and improved facilities for storage of aircraft. Engineers' families will be interested also in the Hurricane Hunters Squadron and the Air Rescue Squadron which are based at Kindley Field. The Annual Convention Committee and the Air Transport Division are joint sponsors of the inspection trip, to which the commanding officer of the base will be host.

It is expected that many will wish to enjoy the outstanding holiday facilities of Bermuda while making the trip. With this in mind, the pleasant Hotel Princess has been selected as headquarters for the tour, and plenty of opportunity will be given for sightseeing about the Coral Isles.

Leaving New York on October 24, by Giant Constellation flight, the tour will return to New York, also by air, on October 28, giving five full days in Bermuda. The trip has been arranged especially for the convenience of those attending the Annual Convention. Arrangements can readily be made to remain longer in Bermuda by those desiring to do so. The all inclusive price for the tour, including the Hotel Princess is $185.10.

To assure reservations, an early decision is essential. Full informative pamphlets are available on request from Leon V. Arnold, 36 Washington Square West, New York 11, N.Y. Mr. Arnold is the travel consultant who has been in charge of many similar ASCE tours in past years.

The full Convention program will be printed in the September issue of CIVIL ENGINEERING.

New Committee on Conditions of Practice Explained

A new ASCE Committee on Conditions of Practice in the profession, organized at Little Rock, Ark., in April (May issue, page 63), is an important development in Society operation. It is one outgrowth of recommendations of the Task Committee on Division Structure in its report to the Board of Direction in 1952.

In the past, the Society's professional committees, as contrasted with activities of the Technical Divisions, have functioned quite independently and with only casual direction from the Board Committee on Coordination of Professional Activities. On the other hand, the Technical Divisions have had the benefit of coordination and direction from the Committee on Technical Procedure which, in turn, is responsible to the Board Committee on Division Activities.

There has been a growing conviction that the work of certain standing Society committees in fields other than the purely technical should be more closely coordinated. Numerous matters are of concern to two or more committees. A clear understanding of the work of each is important to all. Therefore, following the pattern already developed for Technical Activities, the department of Conditions of Practice has been created.

The accompanying diagram, Fig. 1, shows the organization structure for both departments. It is to be noted that the Board Committee on Coordination of Professional Activities, as such, is abolished. That committee, with slightly expanded membership, now becomes the Executive Committee of the Committee on Conditions of Practice.

In Bylaw language:

"The Committee on Conditions of Practice shall coordinate all the activities of the committees represented on it and shall make recommendations to the Board of Direction with respect thereto. Among other duties it shall review the annual program, needs, and budget of each professional committee and make appropriate recommendations. It shall stimulate or redirect the activities of any professional committee as found necessary. The committee shall meet once each year at a time and place of its own choice, subject to approval by the Board of Direction."

The new committee, with ASCE Vice-President A M Rawn as chairman, held its first meeting in Little Rock, on April 12, for purposes of organization and to consider the scope of its activity. During the coming year Vice-President G. Brooks Earnest will be chairman.

It is the view of the committee that numerous problems in the field of Conditions of Practice are of such importance and such widespread interest as to warrant the presentation of special papers to the membership of the Society. To that end, plans are under way to schedule special sessions on such subjects at Society Conventions from time to time.

Creation of the new department is regarded as a much needed step in rounding out the activities of the Society and in furthering its stated objective of "advancement of the science and profession of engineering."

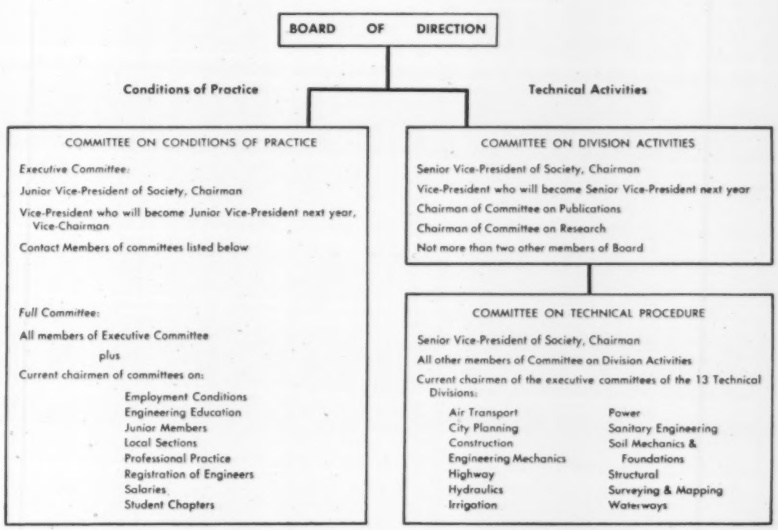


FIG. 1. Organization chart shows method of coordinating activities of ASCE in fields of Conditions of Practice and Technical Activities. Executive Committee of Committee on Conditions of Practice has same membership (slightly expanded) as that of Committee on Coordination of Professional Activities, now abolished.

World-renowned St. Anthony Falls Hydraulic Laboratory will be a major attraction for hydraulics experts attending the forthcoming International Hydraulics Convention, August 31–September 4.

Hydraulic Engineers to Meet in Minneapolis

The forthcoming International HydraulicsC onvention in Minneapolis, sponsored jointly by the Hydraulics Division of the American Society of Civil Engineers and the International Association for Hydraulic Research, will be the focal point for hydraulic engineers throughout the world, August 31–September 4. (See the July issue, pages 59–61, for details of the program.) New developments in hydraulic design and research will be discussed by specialists from this country and abroad to add to the fund of knowledge in the fields of sediment transportation, air entrainment, density currents, and wave and shore structures. These are subjects of increasing importance, both from the point of view of engineering design and engineering economics. There are 49 papers by authors from 13 countries.

In addition to the technical sessions, the convention will provide an opportunity for hydraulic engineers to meet each other, discuss common problems, and develop a mutual understanding with technical experts from many parts of the globe.

In order to help visitors get the most out of the meetings in the limited time, all the papers to be presented will be included in the convention Proceedings and published prior to the convention. The bound Proceedings will be on sale at the time of registration for $4.50, and a limited number will probably be available after the convention at $6.

The technical sessions will be held on the campus of the University of Minnesota in the Auditorium of the Museum of Natural History. Many will want to visit the university's world famous St. Anthony Falls Hydraulic Laboratory. Also of much interest will be the navigation developments of the Upper Mississippi, involving the canalization of the river by means of locks and dams. Visitors may also wish to combine professional interests with vacation pleasure and recreation by taking advantage of Minnesota's renowned lakes and streams.

Tellers Canvass Ballot for 1954 ASCE Officers

June 30, 1953

To the Secretary
American Society of Civil Engineers:

The Tellers appointed to count the Ballot for Official Nominees report as follows:

For Vice-President—Zone I

(Term October 1953–October 1955)

Enoch R. Needles	338
*Irving V. A. Huie	56
Scattering	331
†Ineligible Candidate	77
Void	1
Blank	14
Total	817

For Vice-President—Zone IV

(Term October 1953–October 1955)

Mason G. Lockwood	1,277
Scattering	265
†Ineligible Candidate	54
Void	5
Blank	9
Total	1,610

For Director—District 1

(Term October 1953–October 1956)

William S. LaLonde, Jr.	252
Scattering	153
†Ineligible Candidate	68
Void	0
Blank	16
Total	489

For Director—District 4

(Term October 1953–October 1956)

Oliver W. Hartwell	321
Scattering	21
†Ineligible Candidate	45
Void	0
Blank	1
Total	388

For Director—District 8

(Term October 1953–October 1956)

Thomas C. Shedd	600
Scattering	10
†Ineligible Candidate	23
Void	0
Blank	0
Total	633

For Director—District 11

(Term October 1953–October 1956)

Samuel B. Morris	556
Scattering	124
†Ineligible Candidate	64
Void	0
Blank	14
Total	758

For Director—District 14

(Term October 1953–October 1956)

Ernest W. Carlton	391
Scattering	17
†Ineligible Candidate	25
Void	2
Blank	1
Total	436

For Director—District 15

(Term October 1953—October 1956)

Raymond F. Dawson	525
Scattering	36
†Ineligible Candidate	2
Void	2
Blank	3
Total	568

Total number of ballots counted	5,699
Ballot envelopes without signature	6

Respectfully submitted,
ROBERT E. WHITE,
Chairman
EDWARD L. WINSLOW, JR.,
Vice-Chairman

Burr L. Chase	Arthur R. Luecker
Warren G. Cummings	Herbert M. Mandel
Victor Feigelman	William J. McGraw
Joel E. Fisher, Jr.	James P. Noonan
Henry Goldfinger	Edwin D. Silvers
	Edward N. Whitney

(*Tellers*)

* Withdrawn.

† These votes were cast for incumbent officers who are presently ineligible for reelection in accordance with Section 9, Article VI, of the Constitution.

New Policy for Proceedings Papers Begins in October

With the end of the current fiscal year, September 30, 1953, the present method of ordering Proceedings Separates will be abolished in favor of a new method of distributing Proceedings Papers. This new method was explained in a recent mailing to the entire membership, and in the July 1953 issue of CIVIL ENGINEERING, page 71.

The new method of publishing Proceedings is summarized again as follows:

1. The 13 Technical Divisions will sponsor all papers, and no paper will be printed if it has not been recommended by the appropriate Division.
2. A member of the Society may receive free of charge and automatically all the papers sponsored by *one* Division.
3. To receive these papers a member must be registered at Society Headquarters in the Division (*one only*) whose papers he wishes to receive automatically and free of charge.
4. A member may subscribe to the papers of a second Division for the price of $2.00 per year.
5. A member may subscribe to all papers published for $12.00 per year.
6. Single copies of any paper may be obtained at 25 cents a copy.

If you have not registered in a Technical Division to receive its papers (*one Divison only*) free of charge, please do so promptly by filling out and mailing the Enrollment and Subscription form (page 94) to Society Headquarters.

Centennial of Engineering Symposia Volume Ready

"When the Centennial of Engineering drew to a close it was apparent that the past hundred years had witnessed a story of progress out of all proportion to the preceding centuries. The contents of this volume prove this," wrote Charles F. Kettering, H.M. ASCE, in the foreword to the 1080-page book just released by Lenox R. Lohr, President, Centennial of Engineering, 1952, Inc.

The first 116 pages contain the story of how the Centennial idea took form in 1948 when ASCE Past-President Malcolm Pirnie was appointed chairman of the ASCE Centennial Planning Committee; the theme and philosophy of the ten-day celebration held in Chicago; the addresses made at the Awards Luncheon on September 10, 1952, considered by many to be the highlight of the Centennial; Mr. Kettering's address, "A Review of the Century" at the Centennial Evening Party; and the script of the play "Adam to Atom."

There follows the complete printed record of the symposium papers and discussions presented during the Convocation period, September 3 to 13, 1952, covering practically every phase of engineering. The twelve overall symposium subjects were selected for their broad influence on the day-to-day lives of our people, and their social, economic and political bearing on the advancement of civilization. These papers dramatize the developments of the past one hundred years and the highly significant part played by engineering in developing the United States to its position of world leadership. The subjects of the twelve symposia are: The Role of the Organized Professions; Education and Training; Food; Tools; Transportation; Mineral Industries; Structures and Construction; Chemical Industries; Communication; Energy; Health and Human Engineering; and Urbanization.

Most engineers will wish to own this history and coverage of the Centennial of Engineering, 1852–1952. It is available at $10 postpaid from either Lenox R. Lohr, its editor, Musem of Science and Industry, Chicago, Ill., or from William N. Carey, Executive Secretary, American Society of Civil Engineers, 33 W. 39th St., New York, 18, N.Y. A coupon to facilitate ordering is provided in the advertising section of this issue.

Commemorative Volume to Honor John I. Parcel

A commemorative volume of technical articles on structural engineering is planned by former students and colleagues of John I. Parcel, M. ASCE, member of the St. Louis firm of Sverdrup & Parcel, to honor him on his 75th birthday, which will occur October 24, 1953. The University of Minnesota Press is being asked to publish the volume.

Former students, colleagues, and friends of Mr. Parcel who wish to contribute funds or technical articles to support the publication are asked to write Joseph A. Wise, Professor of Civil Engineering, University of Minnesota, Minneapolis 14, Minn.

Members Receive Prizes in Highway Contest

A number of Society members won national or state awards in the recent General Motors contest for papers presenting solutions to the problem of "How to Plan and Pay for the Safe and Adequate Highways We Need." Both the second and third national awards went to Society Members. The first award of $25,000, as stated in the July issue (p. 80), was won by Robert Moses, construction coordinator of New York City. The paper which won the second award of $10,000, by Lacey V. Murrow, M. ASCE, executive director of the Association of American Railroads, is printed in full in this issue (p. 36). Also in this issue is a summary of the $5,000 third award paper (p. 82), by Claude A. Rothrock, M. ASCE, state planning engineer, West Virginia State Road Commission.

A list of other Society members who won state and national awards appears below:

William E. Willey, A.M. ASCE, Engineer, Division of Economics & Statistics, State Highway Dept., Phoenix, Ariz. — National Honorable Mention	$3,000
STATE AWARDS	
William R. Nehlsen, J.M. ASCE, Oxnard, Calif.	$ 500
Scott H. Lathrop, A.M. ASCE, Sacramento, Calif.	$ 500
Roderick L. Downing, M. ASCE, Boulder, Colo.	$ 500
Russell L. Culp, A.M. ASCE, Lawrence, Kans.	$1,500
Leroy M. Chace, Jr., A.M. ASCE, North Bridgton, Me.	$1,500
Robert C. Blumenthal, J.M. ASCE, Winthrop, Mass.	$ 500
Joseph W. Chiloro, J.M. ASCE, Saginaw, Mich.	$ 500
Charles L. Miller, J.M. ASCE, Jackson, Miss.	$ 500
Harry Rubey, M. ASCE, Professor, Dept. of Civil Eng. Univ. of Missouri, Columbia, Mo.	$1,500
E. W. Wendell, M. ASCE, Altamont, N.Y.	$ 500
Fred J. Benson, A.M. ASCE, Bryan, Tex.	$ 500
Donald H. Herak, J.M. ASCE, Spokane, Wash.	$1,500
Cecil L. Bower, M. ASCE, Charleston, W. Va.	$1,500
Albert C. Spann, M. ASCE, Cheyenne, Wyo.	$1,500

ASCE MEMBERSHIP AS OF JULY 9, 1953

Members	8,401
Associate Members	10,693
Junior Members	17,181
Affiliates	69
Honorary Members	40
Total	36,384
(July 9, 1952	34,921)

UPADI Takes Steps to Stimulate Inter-American Activities

A western hemisphere federation of engineers and engineering societies came into being in 1951 at a conference in Havana, Cuba. Known as UPADI (Union Panamericana de Asociaciones de Ingenieros), the federation includes engineering organizations in South and Central America, the Engineers Joint Council, and the Engineering Institute of Canada —nine in all.

With the overall purpose of encouraging promoting, guiding, and standardizing the efforts and practices of all engineers of the Americas, UPADI proposes some specific activities, among them the holding of periodic Pan-American Engineering Congresses; the interchange of teachers, students, and lecturers among universities and engineering associations; the organization of technical, professional, economic, and social interchange among the members of the constituent societies; promotion of the study of public works and economic problems of Inter-American character; and an effort to utilize the talents of engineers to a greater extent in the countries of the Americas.

At its New Orleans Convention in August 1952, several specific activities were set in motion. A committee is at work studying matters of international engineering concern such as technical terminology, standards, and drafting-room practice. Steps are being taken to implement the exchange of students and teachers, and to make employment opportunities available to recent graduates.

Engineers Joint Council's Committee on International Relations has organized a subcommittee on UPADI to deal with these matters. Several task groups of the subcommittee have been named to handle publicity, society relationships, engineering education, exchange of publications, and international organization.

The next UPADI convention is set for Sao Paulo, Brazil, in 1954.

NSPE Finds EJC Unity Plan Unacceptable

Too many unresolved problems is the reason given by the Board of Directors of the National Society of Professional Engineers for failing to accept, at this time, the invitation of Engineers Joint Council to join that group. The board called for representatives of NSPE to offer to meet, as soon as possible, with representatives of EJC to discuss new approaches to unity of the engineering profession. The board, which represents NSPE's 39 state societies, pointed out that unity of the profession is of paramount importance, but that the means for accomplishing it needs further clarification.

EJC has extended invitations to several engineering societies, among them NSPE, to become members. Three—the American Society for Engineering Education, the American Water Works Association, and the Society of Naval Architects and Marine Engineers—have accepted affiliation. The enlarged EJC is a direct result of two-year deliberations of an Exploratory Group for Unity of the Engineering Profession. The group, composed of representatives from leading engineering societies (of which NSPE was a member), considered four plans that could lead to greater unity.

Appointments to Technical Division Executive Committees

John P. Hart, of Tacoma, Wash., was appointed to the Construction Division. His photo is not available.

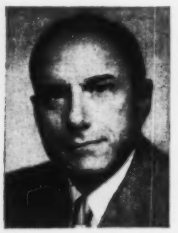
Joseph D. Blatt
Air Transport

John S. McNown
Engineering Mechanics

W. M. Lansford
Hydraulics

Richard Hazen
Sanitary Engineering

Ralph B. Peck
Soil Mechanics & Foundations



Warren Raeder
Structural

Oscar J. Marshall
Surveying & Mapping

New Daniel Mead Prize Subjects Are Announced

As announced in the abstract of the recent Miami Beach meeting of the Board of Direction, the Board on recommendation of the Committee on Professional Conduct has approved the subjects for the 1954 Daniel W. Mead Prize Contest. Junior Members will write on "Ethics of the Resident Engineer in his Relations with the Contractor." For students the designated subject is, "To What Extent Should an Employer or Supervisor Give Credit to Assistants and Subordinates for Engineering Work Done Under His Direction?" All papers intended for entry in the competition should be in the hands of the Executive Secretary of ASCE not later than June 1, 1954.

The prizes, which were established and endowed in 1939 by the late Daniel W. Mead, Past-President and Honorary Member of ASCE, consist of a Junior Member award of $50 in cash and a certificate, and a student prize of $25 in cash and a certificate.

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

No Competitive Bids for Professional Services

Several unfortunate problems of competitive bidding for professional services have recently arisen. Their satisfactory solution constitutes an important development in the Society's Washington operations.

Acquiescence in competitive bidding for professional services would completely undermine the status of the engineer as a professional man. Hence the Society, through its Committee on Professional Practice and its Washington office, attempts to combat this unsound practice whenever it arises in government operations. The Society tries to emphasize that its objective is not as much the protection of the engineers as it is the protection of the public. It emphasizes that to spend more than the minimum amount possible for engineering services may result in a lower total project cost.

Strange to relate the most recent cases of competitive bidding arose in two agencies of the highest repute, which generally follow accepted practices. In one case a subdivision of the Atomic Energy Commission invited simultaneous written proposals from about twenty engineers and architects. Conferences between officials of the Commission and representatives of various engineering and architectural societies resulted in a satisfactory procedure in this case. As a matter of fact, the AEC regulations provided for engaging professional services in complete keeping with the recommended procedures of the technical societies.

In a still more recent case the Federal Housing Authority, a relatively conservative agency of high repute, asked for sealed bids for:

> "Sanitary engineering services, complete, as necessary for the planning, specification and design of a sewer system and sewage disposal plant as described herein, all for the sum of . . . . "

In requesting these bids a regular supply-contract form, such as would be used for ordering bolts or nuts or other supplies was used, making the situation particularly objectionable. Study the needs, design the plant, write the specifications—all in a single package for a single lump sum bid! The four firms specifically invited to bid refused to do so. One sealed bid was received. In defense of the FHA, it should be stated that this reputable agency is normally concerned with the problems of home financing rather than those of construction. In this instance, however, a large project near Miami, Fla., (the Larchmont Gardens Housing Project) had been repossessed by the government, and it was necessary to build a sewer system and disposal plant.

The project was largely a local matter involving the Florida office of the agency and various Florida engineers. For this reason it did not come to the attention of the ASCE Washington office until several days before the proposed bid opening. Since architectural as well as engineering services might be required by the agency, the National Joint Cooperative Committee of ASCE and AIA would eventually consider the matter. Accordingly, the Field Representative was accompanied by the chairman of the appropriate AIA committee in conferring with FHA officials. The agency's attorneys had ruled that competitive bids were required by law. The chairman of the ASCE Committee on Professional Practice authorized the Field Representative to pursue the matter further.

In an exchange of correspondence* between the Field Representative and Guy O. Hollyday, Commissioner, Federal Housing Administration, in June and July, Mr. Hollyday agreed that "a contract will not be awarded on the basis of the invitation for bids issued in connection with the Larchmont Gardens Project." Instead, on suggestion of the Field Secretary, he obtained authority from the General Services Administrator to enter into a negotiated contract under the provisions of Title III of the Federal Property and Administrative Services Act of 1949.

The following official delegation of authority was published in the Federal Register on Friday, July 10, 1953, happily overcoming the obstacles to following accepted practices and to observing the codes of ethics of the profession:

"GENERAL SERVICES ADMINISTRATION"

"Administration of Housing and Home Finance Agency
"Delegation of Authority to Negotiate Contracts for Services of Engineering and Architectural Firms

"1. Pursuant to authority vested in me by the provisions of the Federal Property and Administrative Services Act of 1949, as amended, hereinafter called the act, authority is hereby delegated to the Administrator of the Housing and Home Finance Agency to negotiate, without advertising, under section 302 (*c*) (4) of the act, contracts for the services of engineering and architectural firms when such services are incident to the repair and improvement of properties and projects acquired in the program operations of the Housing and Home Finance Agency.

"2. This authority shall be exercised strictly in accordance with Title III of the act.

"3. The authority delegated herein may be redelegated to any officer or employee of the Housing and Home Finance Agency.

"4. This delegation shall be effective as of the date hereof.

"Edmund F. Mansure,
"Administrator"

The situation discussed above indicates the desirability of bringing instances of competitive bidding to the attention of the Committee on Private Practice (G. J. Requardt, chairman) or to the attention of the Washington office at the earliest possible moment. The authority of the General Services Administrator to make such a delegation is very broad and applicable to most agencies. We believe that the General Services Administrator appreciates the iniquity of competitive bidding for professional engineering services. Although this particular delegation is one of the first made and is hence pioneering a new field, it seems reasonable to believe that it may be available in a similar situation in the future as a simple solution of a distressing problem.

Washington, D.C.
July 20, 1953

[* Interested members may obtain copies of the exchange of correspondence from Executive Secretary W. N. Carey at Society Headquarers, 33 W. 39th Street New York 18, N. Y.]

Data for ASCE Membership Directory Requested

The next Membership Directory will be issued early in 1954. It will carry address data of record in the Society's files as of September 30, 1953. In order that the Directory may be as complete and useful as possible, all members who have not furnished the headquarters office with up-to-date personal information are urged to do so. The information should include (1) full name, (2) name and address of organization with which associated, (3) title of position with the organization, (4) complete residence address, and (5) indication of mailing address to be used—business or residence.

Postal card requests for reporting changes of address will not be sent to members. Each one will be responsible for supplying information as to change of address or occupation. In order to meet production schedules, changes recorded later than September 30 cannot be carried in the Directory.

For the convenience of members, the coupon on page 83 of this issue may be used.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

At the May meeting of the **Akron Section,** the members were entertained at the St. Francis Hotel in Canton as guests of Macomber, Inc., in what has come to be an annual event. Following an inspection of the Macomber plant in the afternoon, and cocktails and dinner at the hotel, the host and chief speaker, Stanley Macomber, gave a talk illustrated by colored slides, describing the V-Lok building developed by the firm at the request of the U.S. Army for use as barracks. In this building the structural steel framework is assembled without the aid of bolts, pins, rivets, or other loose parts.

Two **Alaska Section** groups—the **Anchorage** and **Fairbanks Subsections**—honored visiting Hawaii Section President George Wallace and Mrs. Wallace at their June meeting. At both gatherings Mr. Wallace discussed Hawaiian technical projects of interest, and described the success of his Section in keeping its members aware of developments in all fields of their profession by scheduling classes for their benefit.

There was a good turnout of **Buffalo Section** members for the June meeting which consisted of an inspection tour of the Sir Adam Beck Niagara Generation Station No. 2 at Queenston, Ontario. Preceding the tour, the members were luncheon guests of the Ontario Hydro Commission. William Hogg, assistant project engineer, briefed them on the development.

The **Cincinnati Section,** at its dinner meeting on May 6, voted to invite the ASCE to hold its February 1956 Convention in Cincinnati. The address of the evening was by Dr. Arthur E. Morgan, past chairman of TVA, now president of the Community Service, Inc., who told of his experiences in India, taken as typical of other backward areas in need of our engineering leadership.

Ways of making the engineer known to the non-engineer were discussed at the May 26 meeting of the **Central Illinois Section** by Lisle Rose, editor and director of *Engineering Information and Publications.* A new course is being offered at the University of Illinois to give those working with engineers an idea of engineering philosophy and methods, Mr. Rose said. Students receiving awards of Junior membership in ASCE, in the Section's annual competition, were Roy Elam, Jr., Clarence J. Sikorski, and John Robert Messner, Jr.

In keeping with its custom, the **Central Ohio Section** held its May meeting with the Ohio State University Student Chapter, which arranged the program. It was a big night for the students, who received all manner of prizes. William W. Fallon won both the Section prize of $10 and the Simpson Award of $72. Three students—Charles H. Hanshaw, Douglas Downey, and Walter A. Ramsy—were awarded $270 Brown Scholarships, and two others—Bernard Reich and James A. Kise—received $300 scholarships provided by the Ohio Contractors Association. The speaker of the evening was Don Cooley, of Battelle Memorial Institute, and the subject "Non-Destructive Testing."

The **Cleveland Section** has been active in a program intended to stimulate the interest of high school students in choosing engineering as a career, sponsored by the Cleveland Technical Societies Council in the school year just past. The program featured half-hour telecasts, put on every Sunday afternoon for four or five months. Each of the cooperating societies was given a chance to take over one or more of the programs to further the cause of its particular branch of engineering. Costs were financed by subscriptions from local industries. The Council also sponsored several conferences with high school seniors, which gave the various groups direct opportunity to sell the students on their particular branch of the profession. As the result of its work on the program, the Cleveland Section notes the need for a "good brochure expounding in an attractive manner the reasons for choosing a career in civil engineering . . . and a 16-mm movie film of a large number of civil engineering projects."

ASCE President Walter L. Huber discusses student problems with Jim Roberts (center) and Frank Salfinger, of the University of California Chapter.

Outstanding students selected by the **Colorado Section** as recipients of its 1953 Junior membership awards are Rodney D. Page, University of Colorado; Roger W. French, University of Denver; and David W. Fonken, Colorado A & M College. The awards were presented at the Section's annual Student-Junior Night, at which Junior Members of the Section handled all arrangements. Dean Francis M. Dawson, ASCE Director for District 16, was the featured speaker. The June meeting took the form of a picnic and barbecue at Graystone Ranch in Bear Creek Canyon, west of Denver. The meeting was arranged by the Ladies Committee and attended by 118 members, wives, and guests.

Precast and prestressed concrete was the subject of discussion at the June 18 meeting of the **Intermountain Section,** headed by Ralph E. Spears, district engineer for the Portland Cement Association.

At its May dinner meeting the **Oregon Section** unanimously voted to invite the Society to hold one of its summer Conventions in Portland at the first opportunity. In a talk on "Aerial Topographic Mapping," K. B. Wood, of the local firm of K. B. Wood and Associates, Inc., gave a brief history of photogrammetric map making and outlined in detail the different phases in the preparation of maps by the method. He

Nathan M. Newmark (third from left), professor of mechanics at University of Illinois, is principal speaker at luncheon meeting of Vicksburg Branch of Mid-South Section held in Waterways Experiment Station cafeteria. Shown, in usual order, are H. E. Weller, program chairman, Vicksburg Branch; W. J. Turnbull, chief of Soils Division, Waterways Experiment Station; Professor Newmark; D. O. Coe, president, Vicksburg Branch; Col. C. H. Dunn, director of Station; and J. F. Redus, vice-president, Vicksburg Branch. In Vicksburg to attend a conference on stress distribution in soil masses, Dr. Newmark described the phenomena immediately following an atomic-blast detonation and gave an idea of the magnitude of the forces produced. He explained that such forces cannot be absorbed practically by materials within their elastic range and said that protective designs must use materials at strengths much nearer their ultimate.

also demonstrated the use of the multiplex machine, which is used for reading elevations from aerial photographs. Comparative cost figures for this type of work, he said, indicate quite a saving over conventional ground surveying work.

Departing from their usual custom of foregoing meetings during the summer months, members of the **Rochester Section** arranged a special program on prestressed concrete for June 17 "because of the increased interest in the field and the potential application to projects on which they are working." The speaker—James A. Ryan, of Capitol Engineering Associates, concentrated on prestressing as applied to bridges and furnished a typical prestressed bridge design computation for reference in the discussion period that followed his talk. A Portland Cement Association movie on prestressed concrete bridges concluded the program.

Following a smorgasbord dinner, the **Tacoma Section** at its May 12 meeting heard a talk on coaxial and microwave transmission of radio, telephone, and television signals. The speaker, Maurice B. Hickey, is manager of the Tacoma office of the Pacific Telephone and Telegraph Co.

Houston Branch Movement Aimed at Public Service

A plan to induce civil engineers to be more active in public affairs, by the Houston Branch of the Texas Section, is being widely commended by the local press. Growing out of the belief that engineers as "creators and builders" have a duty beyond their profession, the Branch last fall formed a permanent standing committee at Section level called the Development Committee.

The committee intends to promote activities that will "embrace not only engineering, but the much wider and very important field of human relations, and . . . inspire and lead people in major matters of policy concerning the welfare and development of their respective communities and of the nation." In particular, it recognizes the need of reaching young engineers and encouraging them to "take part in public affairs and civic activities, to accept the responsibilities and assignments on community programs so as to develop confidence, to broaden vision, and to develop leadership." To reach these young men the committee is working with counselors from colleges and high schools in the area, personnel directors and department heads of large Houston firms, and local newspaper columnists. Houston editors and columnists writing on the plan see it as already productive of much good in arousing general awareness of the need for more and better attention to public business.

Al Bahn, president of the Houston Branch, was instrumental in forming the Development Committee, on which he serves as ex-officio member. Walter E. Dickerson is chairman; Howard Tellepsen, vice-chairman; Robert M. Olson, secretary-treasurer; Warren S. Bellows, Sr., and W. P. Cornelius, counselors.

Members and guests of the District of Columbia Section watch tilt-up erection of 16-ton precast concrete wall panel in huge warehouse project. Only small part of group of 350 visitors appear in this view.

D. C. Section Sponsors Large Inspection Trip

The Parr-Franconia Warehouse Project, nearing completion at Franconia, Va., a few miles south of Washington, was the objective of a large inspection trip made by the District of Columbia Section and its guests on June 13. Containing over 1,250,000 sq ft, the project is one of the largest engineered timber structures in the country. It is unusual in its use of tilt-up concrete walls and timber roof trusses, as well as for speed of erection. Although work did not start until last December, the smaller building (500 by 500 ft) was completed within 90 days after ground breaking, and the larger structure (500 by 2,002 ft) is schedule for completion in August—only nine months from the start of construction.

A key factor in the speed of construction are the Arch-Teco bowstring timber roof trusses used throughout. A total of 773 of these trusses, each with a span of 71 ft, 3 in., were prefabricated in Portland, Oreg., by Timber Structures, Inc., shipped to the job site, and assembled with Teco split-ring connectors.

Only 545 solid-timber columns, in addition to the exterior concrete columns, were necessary to support the 28 acres of roof. This average of about 20 supports to the acre provides a maximum of unobstructed space for storage, and increases the efficiency of mechanized handling equipment to be installed. Both speed of construction and clear-span space advantages are achieved economically with the timber trusses.

Another modern construction method contributing to the speed and economy of the project are the precast "tilt-up" concrete wall sections. These pre-cast panels, each measuring about 20 by 26 ft and weighing 16 to 18 tons, are lifted into position by crane, then jointed and sealed with poured-in-place concrete columns.

Professional interest in the project was evidenced by the attendance of over 350 Washington engineers and architects, including members of the Washington Metropolitan Chapter of the American Institute of Architects and the D.C. Society of Professional Engineers, who were guests of the Section. The inspection tour was preceded by a picnic luncheon given by Timber Structures, Inc., Timber Engineering Co., the lumber industry's research organization in Washington, and James H. Carr, Inc., Washington representative for both organizations.

Barrett & Hilp, Inc., general contractors of San Francisco, are building the project for the Parr Warehouse Co. for lease to the government, for use as a storage center by the General Services Administration. The architects are Ward & Bolles, also of San Francisco.

Coming Events

Los Angeles—Junior Forum luncheons every Friday at various Los Angeles restaurants. Call Chuck Gorham, MI. 4211, ext. 456, before 9 a.m. on Fridays for information and reservations.

Oklahoma—Fall meeting at Tulsa, Okla., on September 19.

Providence—Meeting on October 8 features talk by Edgar P. Snow, on "Subaqueous Tunnel Construction."

Sacramento—Weekly luncheons every Tuesday at the Elks Temple, Sacramento at 12 noon.

Texas—Fall meeting at the White Plaza Hotel in San Antonio, Tex., October 14–16.

Scheduled ASCE Conventions

NEW YORK CONVENTION
Hotel Statler
October 19–23
1953

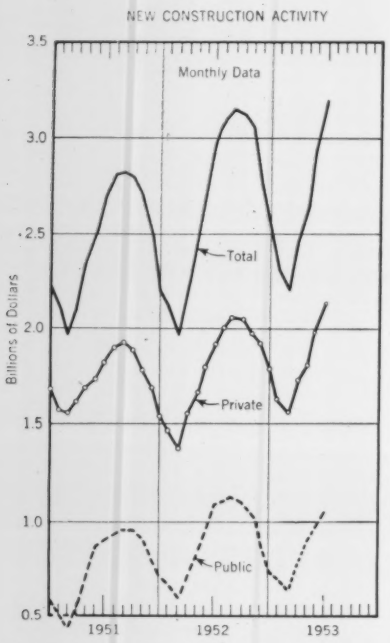
ATLANTA CONVENTION
Atlanta, Ga.
Hotel Biltmore
February 15–19, 1954

ATLANTIC CITY CONVENTION
Atlantic City, N.J.
Chalfonte-Haddon Hall
June 14–19, 1954

NEWS BRIEFS . . .

Construction Volume Soars

Optimistic forecasts for this year's construction volume seem well justified at the mid-year mark. The first half of 1953 found expenditures for new construction at an all-time high of $15.9 million, almost 8 percent above the first half of 1952, according to the U. S. Department of Labor's Bureau of Labor Statistics and the Building Materials Division of the Department of Commerce. Even after adjustment of the dollar volume to account for price differences the construction volume set a record.



Construction expenditures for first half of 1953 are at all-time high, as shown in Department of Commerce curves.

Seasonal gains during June brought private expenditures for commercial building and public utilities to previously unequaled monthly levels of $152 million and $399 million, respectively. Highway expenditures for the month reached $335 million. The June construction outlay of 3.2 billion represented an advance of 9 percent over the May total and of 8 percent above June 1952.

Commercial construction for the six-month period—January to June 1953—amounted to $729 million, or 43 percent over the 1952 levels. Private construction of public utilities for the first half of 1953, at $2 billion, is 9 percent over last year's figure, the previous six-month high. The $1.2 billion figure for highway construction also represents an all-time high.

Significant declines from a year ago were registered by public and private hospital construction. Private industrial construction, although only slightly behind last year, continued its gradual decline.

Government spending for new construction continues with the total volume of new construction for the year expected to exceed $34 billion.

New York Firm Awarded Hampton Roads Project

Engineering work for the 21-mile Hampton Roads crossing, (August 1951 issue, page 70), to be built by the Virginia Highway Department, will be handled by the New York firm of Parsons, Brinckerhoff, Hall & Macdonald. Combining bridges, highways and a subaqueous tunnel, the project will provide a direct connection between Route 168 in Warwick City and Norfolk, where it will terminate at a junction with Cottage Toll Road. It will go through Hampton City and under Chesapeake Bay at Hampton Roads. More than 27 structures are involved in the project, ranging from small river bridges to long high-level trestle structures. There will be about 17 miles of highways.

The water crossing will consist of 2.3 miles of trestle approaches and a tunnel approximately 1.3 miles long. The subaqueous section of the tunnel will be a single tube carrying a 23-ft roadway. Its portals will be built on man-made islands from material dredged out of the bay.

Initially, one 24-ft roadway will be constructed from Route 168 to the northern approach to the tunnel, and provision will be made for adding a dual 24-ft roadway when traffic warrants. The approach trestle structures to the tunnel portal will carry a 34-ft roadway. The southern approach to the tunnel will follow an existing dual highway, which will be widened to provide 30-ft roadways.

New Jersey Tackles Its Second Toll Highway

New Jersey is making rapid progress with its second self-liquidating toll highway, the 165-mile Garden State Parkway under construction between Paramus and Cape May. Work on construction contracts totaling $70,000,000 for 80 miles of the route is in progress. When completed it is estimated the project will cost $285,000,000. Sections are being opened to traffic as they are finished. At present sections 14 miles long are in use.

Largest of the 370 parkway structures is the 4,400-ft high-level crossing over the Raritan River, a $10,000,000 two-lane bridge. The parkway crosses marshland in the vicinity of Matawan and Cheesequake creeks, where for two miles the swamp is being stabilized by the same sand-drain methods used on the New Jersey Turnpike (described in CIVIL ENGINEERING, January 1952, page 51).

Construction was authorized by the State Legislature in April 1952. A rapid construction schedule is aimed at finishing major portions of the parkway by January 1954, and completion by June of that year. Harold W. Griffin, M. ASCE, heads the engineering staff of the New Jersey Highway Authority. General consultant on the overall project is the firm of Parsons, Brinckerhoff, Hall and Macdonald, which is coordinating the efforts of sixteen separate consulting firms engaged on design and supervision of construction of specific parts of the highway.

Route of Garden State Parkway shown in relation to New Jersey Turnpike.

$11,000,000 Elevated Highway Bypasses Congested Waterfront

Construction of a 1.6-mile section of dual express highway is well on its way towards relieving one of New York's major traffic headaches. The section runs from the Battery underpass north to the Franklin D. Roosevelt Drive and passes under the Manhattan and Brooklyn bridges. Cost of the elevated structure is a whopping $11,000,000. When completed, only a two-mile gap will remain in the dual express highway circling Manhattan Island. The new structure will carry traffic over one of the most congested sections of Manhattan's eastside waterfront, enabling through traffic to bypass the famed Fulton Fish Market and the truck traffic centered about the many other markets and the shipping piers in the area.

The structure stands on two-column bents with 35 ft between columns. Cantilevers of 18 and 22 ft make up the 75-ft width of the structure. Long spans between bents range from 70 to 120 ft in order to minimize interference with trucking operations in the street below and to span rapid transit tunnels. The structure stands on H-piles driven to rock depths ranging from 35 to over 200 ft. The number of piles per footing varied from 3 to 11 with concrete caps and billets $3^1/_2$ to $5^1/_2$ in. thick without grillages. The roadway is 75 ft wide with two 33-ft lanes separated by a 4-ft center mall and with two $2^1/_2$-ft safety walks. Pavement is $1^1/_2$-in. asphalt without binder, and is laid directly on a screeded and broomed 8-in. concrete slab. Construction began at noon each day to avoid congestion of heavy morning market traffic, and continued until dark. Erection is scheduled for completion August 27, 1953.

The structure was designed by engineers in the office of the Borough President of Manhattan under the supervision of Jacob M. Friedland. Resident engineer is John T. Carroll and superintendent for the Fehlhaber Pile Co., the prime contractor, is E. Sirles. Bethlehem Steel is fabricating and erecting the steel work with George P. Adair in charge. Euclid Concrete Corp. is doing the concrete work.

Girder for New York's new $11,000,000 South Street elevated highway from the Battery underpass to the Franklin D. Roosevelt drive is shown being set by crawler crane. New highway section will enable heavy traffic to bypass the busy waterfront area.

University of Florida Is Host to Big ASEE Convention

The nation's top engineering educators were advised to make the best use of America's scarcest resource—present and future engineers—at the recent convention of the American Society for Engineering Education in Gainesville, Fla. Outgoing ASEE President W. R. Woolrich warned the 2,000 delegates, assembled at the University of Florida June 22–26, that engineering talent must be used more efficiently than it is now, and that "we must look to the high schools and secondary schools to select and counsel the ablest future engineers." He pointed out also that a "combination of inelastic college financial budgets, . . . and rising pay scales in industry is causing desertion of the engineering teaching profession to industry at an accelerated rate." Unless definite action can be taken before fall there may be a "serious deficiency of engineering teachers in 1953."

Unity in the Profession Makes Progress

The profession needs a single, strong organization to represent it with respect to professional, social and economic problems, A. B. McEachron, professional employee relations consultant for the General Electric Co., told the delegates. This is not a new idea, he admitted, because for many years there has been such a need, but while engineers are attempting unification through Engineers Joint Council or the National Society of Professional Engineers, a federation of labor unions (the Engineers and Scientists of America) has come into an already complicated picture of unity organization. "Union principles of militant collective action are inconsistent with the ethics of the professional engineer, physician or lawyer," according to Mr. McEachron. He acknowedged that many professional employees are not receiving the consideration they deserve in such respects as just compensation, adequate personal recognition, and their professional problems.

Accrediting Standards to Be Raised

L. E. Grinter, M. ASCE, dean of graduate studies and director of research, University of Florida and new president of ASEE, headed a Committee on the Evaluation of Engineering Education, which reported a "preponderance of evidence that a significant number of engineering curricula are not adequately preparing the engineering graduate." This Committee stated its strong belief that "the accrediting function of ECPD cannot of itself effectively or properly carry the load of advancing the minimum standards of engineering curricula," and recommended: "a substantial raising of the minimum standards of accreditation of undergraduate curricula by ECPD; and that (ASEE) go on record in approval of such advancement of minimum standards." By action of the General Council of ASEE on June 22 this became a statement of ASEE policy and purpose.

Linton E. Grinter

Harry S. Rogers

Elections and Awards Announced

Other new ASEE officers are Dean B. R. Teare, of Carnegie Institute of Technology, who was elected to junior vice-presidency, and George W. Frankau, a New York publisher, who was made treasurer. Honorary memberships, the first given by ASEE, were bestowed on Dean A. A. Potter, of Purdue, and Dean Emeritus Harry P. Hammond, M. ASCE, of Pennsylvania State College. Both are former presidents of ASEE and former recipients of the Lamme Medal. Harry S. Rogers, M. ASCE, president of Brooklyn Polytechnic Institute, was awarded the 26th Lamme Medal, as the year's distinguished engineering educator and contributor to engineering research. Prof. Frederic Obert, of Northwestern University, received the George Westinghouse Award, which annually recognizes a young engineering teacher of outstanding ability. Prof. N. A. Christensen, M. ASCE, head of civil engineering at Cornell University, was elected chairman of the Division of Graduate Studies, and Prof. Joseph A. Varga, J. M. ASCE, University of Detroit, was named to chairmanship of the Division of Architectural Engineering.

Wilbur Dexheimer Sworn in as Reclamation Commissioner

President Eisenhower announced the appointment of Wilbur A. Dexheimer, M. ASCE, as Commissioner of the Bureau of Reclamation on July 13, and he was sworn in the same day. Mr. Dexheimer, now assistant chief construction engineer of the Bureau of Reclamation in Denver, has been with the Bureau since 1928, with time out for three years of military service as assistant theater engineer on General Stilwell's staff in the China-Burma-India theater, and a year and a half as consulting engineer for the Morrison-Knudsen International Co., making studies and reports on railroads, ports, highways and hydroelectric plants in China.

For the Bureau he was field engineer for two years in direct charge of construction of Bartlett Dam, the world's highest multiple-arch dam, and for four years in charge of the construction of Shasta Dam and appurtenant structures. Since 1947 he has had technical supervision for the Bureau of the construction of dams, power plants, canals, and transmission lines including cost estimates and negotiations with contractors. For short periods in 1950 and 1952 he advised the Commonwealth of Australia and the Snowy Mountains Hydroelectric Authority on design and construction procedures for its proposed $900,000,000 hydroelectric and irrigation project. Mr. Dexheimer is a native of Colorado and a 1926 graduate of Colorado A & M College. He is a member of the U. S. Committee on High Dams.

W. A. Dexheimer, M. ASCE

As noted in the May issue (page 63), Secretary of Interior McKay had recommended the appointment of Marvin Nichols, M. ASCE, of Fort Worth, Tex., as commissioner, but Mr. Nichols withdrew his name after opposition to the appointment developed. He said his prior service under the Truman administration "might at some later date be embarrassing to the present administration should I be appointed."

ASTM Elects New Officers at 56th Annual Meeting

Announcement of the election of 1953–1954 officers for the American Society for Testing Materials was made at the organization's 56th annual meeting held in Atlantic City, June 28–July 3. Named as president for the coming year was Leslie C. Beard, Jr., assistant director of Socony-Vacuum Laboratories. Dr. Beard was one of the early contributors to the art of improving petroleum products through the use of additives. Claire H. Fellows, director of the Engineering Laboratory and Research Department of the Detroit Edison Co. was elected vice-president.

New directors are Niel A. Fowler, Des Plains, Ill.; Richard T. Kropf, New York, N.Y.; Theodore E. Olt, Middletown, Ohio; John R. Townsend, Alberquerque, N. Mex.; and Kenneth E. Woods, M. ASCE, Lafayette, Ind.

The new officers were introduced to the membership at the president's luncheon at the Chalfonte-Haddon Hall Hotel.

The wide range of the technical program is indicated by the titles of the symposiums: Metallic Materials at Low Temperatures; X-Ray Spectrographic Analysis; Radioactivity in ASTM Work; Electron Metallography; Lateral Pile Load Tests; Porcelain Enamel; and Soil Dynamics. In addition, there were symposiums on steel, fatigue, methods of atmospheric sampling and analysis, concrete, plastics, significance of tests of concrete, and corrosion.

Kew Gardens Interchange Nears Completion

Construction of Kew Gardens Interchange, between major highways on Long Island, New York, is nearing completion with the opening to westbound traffic of a connection (1) between Van Wyck Expressway (2) and Queens Boulevard (3). Other main highways passing through the interchange are Interboro Parkway (4) and Grand Central Parkway (5). Normal highway construction has been complicated by the requirement that traffic be maintained through the area on temporary bridges and detours. All structures are completed and remaining paving will be ready for traffic in August. Construction, under supervision of Bertram D. Tallamy, M.ASCE, superintendent of State Department of Public Works, has been paid for by state with federal highway aid. New York City and state have defrayed cost of land. Robert Moses is construction coordinator for the city.

Lehigh University to Have New Testing Laboratory

Ground has been broken for Lehigh University's new testing center at the Fritz Engineering Laboratory, which will house the world's largest vertical universal testing machine. The new hydraulic tension-compression machine will have a capacity of 5,000,000 lb. Additional fatigue torsion machines to be added in the future will extend the scope of studies carried on at the laboratory. Other features of the new building will be the modern photoelastic laboratories, photographic dark rooms, a metallographic laboratory, and offices and conference rooms for the research staff.

First Failures Noted in WASHO Road Test

Anticipated failures are beginning to appear in underdesigned sections of the WASHO Test Road near Malad, Idaho, according to an announcement from the Highway Research Board, which is conducting the tests to determine the relative load-carrying capacity of various thicknesses of pavement and base combinations ranging from 6 to 22 in. over a soil typical of that found in large areas of the West.

Since June 11, test trucks with tandem axles loaded to 32,000 and 40,000 lb per pair of axles have been operating over varying thicknesses of asphalt pavement in the two lanes of one test loop. Single-axle units, loaded to 18,000 and 22,400 lb a single axle, operate over identical pavements in another test loop. Since the moisture content of the subgrade soil increases in the spring, the underlying soil is less stable than it was last fall. Consequently the first thousand or so applications this summer have caused marked damage to some of the 6-in. sections, amounting to failure in the wheel path nearest the pavement edge. Damage has also been noted in some spots in the outer wheel path of the 10-in.-thick sections, but aside from minor depressions in the wheel paths, no serious wearing is so far evident in any of the 14, 18, or 22-in. sections. Results so far were anticipated by the engineers who designed the test road. Minor pavement failures consisting of rutting and cracking of the asphaltic concrete surface are repaired by means of thin bituminous "skin patches," and study of pavement behavior in these areas will be continued.

The WASHO Road Test is sponsored by eleven Western State Highway Departments, with the cooperation of the Bureau of Public Roads, truck and trailer manufacturers, and the petroleum industry. The regular 1953 traffic tests will continue until late fall when the subgrade freezes. Present plans for 1954 call for operation during the spring break-up when the frost goes out of the subsoil.

AEC Awards Contract for Atomic Power Plant Study

A design study of "a nuclear power plant for use in an isolated high-cost power area" has been authorized by the Atomic Energy Commission, which has awarded a contract for the work to Walter Kidde Nuclear Laboratories, Inc., Garden City, N.Y. The study will concentrate on a plant of 30,000-kw capacity. The plant would be a "single-purpose" reactor designed to produce power only, and it would use light water as a moderator and coolant. The study will be completed late this year.

One of the first independent research laboratories devoted to the development of commercial atomic power, the Walter Kidde Laboratories has directed a major part of its effort to the development of a low-cost reactor, which it describes as "the key to economical atomic power."

Contract Given for New Delaware Bridge Foundations

Award to the Merrit-Chapman & Scott Corp. of a $3,400,410 low-bid contract for construction of the foundations for the two anchorage piers of the new seven-lane suspension bridge across the Delaware River between Philadelphia, Pa., and Camden, N.J., is announced by the Delaware River Port Authority. The land-based anchorage piers, approximately 240 ft long by 145 ft wide, will be founded at 70 ft below mean high water on the Philadelphia side and at −52 ft on the Camden side. Designed to ease traffic congestion on the existing river crossing a mile to the south, the new bridge features a 2,000-ft suspension span providing 150-ft vertical clearance.

Modjeski & Masters and Ammann & Whitney are consulting engineers on the project.

Precast Reinforced Concrete Slabs Developed for Bridge Maintenance

A precast reinforced concrete slab, for replacing worn-out wooden bridge decks, has been developed by the Arkansas Highway Department for use on federal-aid county road construction. The speed with which repairs are made or a precast concrete bridge erected is one of the chief advantages of these slabs. Cast in heavy steel forms, the slabs are designed for H-15 loading on the basis of 3,000-psi concrete. Under load tests by the Arkansas Highway Department, they are reported to have sustained H-20 loading without failure. Concrete cylinders used have tested 5,000 psi. The concrete is vibrated with internal vibrators and the units are steam cured.

Dimensions of the slab, which is a channel shape, with a diaphragm across the center and each end, are 42 in. wide for the interior section; 42 or 46 in. wide for the curb section unit; and 15 or 19 ft long. By using various combinations of widths and numbers of slabs, a bridge deck of 20 ft or wider may be erected. Two bolts connect the sections transversely and one bolt hole is provided in the ends where multiple spans are used. Depending on the condition of the pile-bent substructure, the slabs may be placed on the original timber pile caps, on new concrete piles and caps, or on a combination of both.

Choctaw, Inc., of Memphis, Tenn., which stocks these slabs have manufactured and erected several bridges for county roads in Arkansas and elsewhere. The photos show a reconstructed county bridge in Mississippi.

Wooden deck of county road bridge (left) on Route 49-E between Yazoo City and Jackson, Miss., was removed, new creosoted timber caps placed on existing piles, and precast reinforced concrete bridge slabs positioned in eight hours.

Revised Budget for Army Civil Functions Approved

The Director of the Budget has approved a revised budget of $471,240,100 for the civil functions of the Army Corps of Engineers for the 1954 fiscal year, according to Maj. Gen. Samuel D. Sturgis, Jr., Army Chief of Engineers. The amounts approved are: general construction, $324,000,000; operation and maintenance, $81,000,000; Mississippi River flood control, $52,540,000; general expenses, $10,200,000; and general investigations, $3,400,000. The request also includes $100,000 for planning the Niagara power development.

The general construction program will be broken down into $230,164,000 for multiple-purpose projects; $42,219,000 for local flood-protection projects; $27,450,000 for flood-control reservoirs; $17,677,000 for navigation channels; $9,540,000 for locks and dams; $3,950,000 for the lower Columbia River fish program; and $3,000,000 for advance engineering and design.

There are no funds for initiation of new projects in the revised budget.

Westinghouse Professorship in Engineering Education

The Educational Foundation of the Westinghouse Electric Corporation recently undertook sponsorship of a George Westinghouse Professorship in Engineering Education of the Pennsylvania State College School of Engineering. Intended to organize and develop an effective program of "teaching engineering teachers to teach," this grant will enable the School of Engineering to subsidize a scientific analysis of engineering educational methods and techniques; a re-evaluation of educational standards and objectives; and a modern, up-to-date program of scientific instruction. With this end in mind Dr. Eric A. Walker, Dean of the Engineering School, under whose direction the new program of engineering education is being formulated, has listed the following as qualifications for the George Westinghouse Professorship.

The recipient shall be a scientist of standing, with a comprehensive knowledge of science and education as well as their theoretical and practical applications to engineering. He must be willing to analyze and re-evaluate the factors determining the liberal engineering education to define and refine the engineering student and his cultural needs in relation to his scientific background. He must gear and correlate the general scientific background of the college or university scene to the developing specialized demands of the industrial scene, anticipating future trends in science and their effect on industry. He must be willing to organize and simplify the basic scientific rules and formulas, relating them to fundamental instruction in all fields of engineering. He will work in cooperation with the American Society of Engineering Education's Committee on the Evaluation of Engineering Education and will attempt to put into practice the findings of that committee as well as those of the ASEE Committee on Improvement of Teaching.

Dean Walker predicts, "though our results may be some time in coming, Penn State's experiment in engineering education is expected to revitalize scientific instruction, and perhaps, to develop some basic methods of education itself."

Thermal Expansion of Invar Tapes Tested by Electrical Resistance

A new method for determining the coefficients of linear thermal expansion of invar geodetic surveying tapes has been developed by Peter Hidnert and R. K. Kirby, of the National Bureau of Standards. Based on a determined relationship between the electrical resistance and the temperature for each invar tape, the technique consists principally of measurements of expansion and electrical resistance of the tape when heated by passing a direct current through it without changing the temperature of the laboratory. The new method is not only more precise but also much more rapid and convenient than the previous method, which required measurements at different ambient temperatures.

Over the past half century, the Bureau of Standards has determined the coefficients of expansion of many invar tapes for government agencies. The measurements are carried out in a specially designed underground laboratory. Until now, the length of each tape was measured at several different constant temperatures from 5 to 35 deg C by comparison with a distance laid off with a 5-meter steel standard maintained at 0 deg C by packing it in melting ice.

Observer notes change in length of invar tape caused by passing direct current through it—new method of determining coefficients of thermal expansion of invar tapes devised by the National Bureau of Standards.

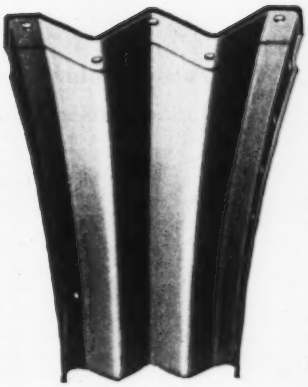
To obtain the various constant temperatures, it was necessary to change the temperature of the entire laboratory. Several days were allowed for the equipment to reach equilibrium conditions at each temperature. Furthermore, additional time and effort were spent in making the large number of precise measurements of length and temperature required.

In the new method, the temperature of the laboratory is held constant at a convenient temperature. The tape, under a specified tension, is supported in the same manner as used in the field, but it is electrically insulated from supporting apparatus. Micrometer microscopes are focused on the terminal graduations of the tape, and the change in length or linear expansion is observed directly when the tape is heated by passing a direct current through it. The electrical resistance corresponding to each observation for linear expansion is determined by a potentiometer method. Measurements of the lengths of the tape by means of the 5-meter steel standard are no longer needed for expansion determinations. The temperature coefficient of resistance of the tape is used to convert the observed changes in resistance to temperature changes. Then, from the length of the tape, the observed changes in length, and the corresponding temperature changes, the coefficient of linear thermal expansion is calculated. The temperatures at which the observations apply are obtained by adding the determined temperature changes to the initial temperature of the tape as determined by thermometers hung in close proximity to the tape.

The temperature coefficient of resistance of each tape can either be obtained experimentally or computed from an empirical relationship derived at the Bureau of Standards between the temperature coefficient of resistance and the mass resistivity of invar tapes. The mass resistivity is easily determined by multiplying the resistance per unit length by the mass per unit length.

Coefficients of expansion of five 50-meter invar tapes obtained by the new method have been found to be in good agreement with those obtained for the same tapes by the old method. The probable errors of the coefficients of expansion determined by the new method are approximately 0.01×10^{-6} per deg C and are less than the probable errors of the coefficients of the same tapes by the former method.

It keeps underground structures from underfoot



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Public Apathy Held Partly to Blame For Our Highway Inadequacies

The first step toward the solution of our highway problems, and the one on which the success of all future steps will depend, is the "awakening of the public to the realities of the highway crisis," states Claude A. Rothrock, M. ASCE, in his paper which won the third national award of $5,000 in the General Motors contest for papers presenting solutions to the problem of "How to Plan and Pay for the Safe and Adequate Highways We Need." (For other material on this contest see pages 36 and 71 in this issue.) Mr. Rothrock is state planning engineer for the West Virginia State Road Commission.

Claude A. Rothrock

The vehicle owner must be brought to think "in terms of total costs of his transportation" instead of "pleading for special treatment favoring his own immediate personal interest," Mr. Rothrock explains. Two things must be recognized by all—that highway costs today are more than double what they were a decade ago, and that the people will ultimately have to pay the cost of any highway program.

Believing that "the present policy of federal aid is not sufficient or sound," since of about $1,600 million in federal taxes on highway users, only $500 million is returned as aid to highways, Mr. Rothrock recommends that "federal aid should be increased to an amount which would at least equal the amount collected by the government from fuel and other taxes paid by road users." He also believes that "the federal government should take over responsibility for construction of the Interstate system" and "should abandon the field of taxation on motor-vehicle users, or at least motor fuel taxes, thus permitting the states to increase their taxes by a like amount. The resulting increased income to the states should, of course, be dedicated to highway purposes." This policy would, he states, "provide a cushioning effect for the economic disruptions certain to follow a decreased federal defense spending program."

In spite of the fact that "many tons of paper have been covered with millions of words . . . yet no really scientific or equable solution is in sight," Mr. Rothrock states, and there is need for a comprehensive program of research to determine, among other things, the equable share of the cost of the highway program which should be borne by the different classes of users.

In the matter of organization, he feels that federal legislation should be obtained that will "create a new federal highway organization higher in the echelon of national affairs, and with greater power and authority than the present Bureau of Public Roads." The federal government should "proceed promptly with a ten-year plan for the construction of the Interstate system, through its own planning and contracting organization, or by 100 percent grants to the states with proper federal supervision." It also should "establish federal-aid to states for the construction of the federal-aid system on a matching basis in an amount at least equal to the total income from imposts on motor vehicles and appurtenances, which amounted to more than 1 billion dollars in 1950."

According to figures for federal-aid highways quoted in the paper, needed improvements on the primary system would cost over $15 billion, those on the secondary system, about $8½ billion, and those on the urban system, over $8 billion, bringing the total of needed expenditures for federal-aid highways alone to more than 32 billions of dollars.

New Steel Mill Starts Operation in Allenport

With recent completion of a $28,000,000 steel mill at its Allenport, Pa., works, the Pittsburgh Steel Company, long a producer of tubular and steel wire products, will broaden its field to include steel sheets. In addition to a semi-continuous hot rolled sheet mill, the project includes buildings to house pickling facilities for cleaning the steel and other finishing and shipping structures. Still under construction is a cold rolling mill for steel sheets, plus annealing furnace and finishing facilities.

Construction was handled by the engineering and contracting firm of Ragnar Benson, Inc., with J. G. Kassab, general manager and vice-president, in immediate charge of the work.

Reduction in Stream Pollution Reported

The nation's progress in reducing the pollution of its water resources through construction of municipal sewage treatment plants is summarized in a recent report released by the U. S. Public Health Service. In 1952, the report indicates, a total of 515 communities in the United States awarded contracts involving an expenditure of $137 million for this type of construction. Of these contracts, 314 were for new plants costing $78,419,556, and 201 for additions, enlargements, or replacements of existing plants, costing $58,789,133.

The report compares the 1952 construction rate for these facilities with the annual rate of from $450 to $500 million, which is estimated would be required over a ten-year period to bring the pollution caused by municipal wastes under reasonable control. The 1952 total of $137 million is less than that for any year since 1948, and also falls short of the long-term average of $141 million for the 1915–1950 period.

Earle B. Phelps, Noted Sanitary Engineer, Dies

Earle B. Phelps, pioneer investigator and internationally known authority on sewage chemistry, stream sanitation, and public health engineering, died at his home at Gainesville, Fla., on May 29. A graduate of Massachusetts Institute of Technology and professor emeritus of sanitary science of the Columbia University College of Physicians and Surgeons, Professor Phelps had been teaching stream sanitation and public health engineering at the University of Florida for the past eight years. He organized and conducted important studies on stream pollution and purification for the U. S. Public Health Service, and had been a sanitary consultant for many other agencies. He was author of several tests and more than 60 technical articles.

Earle B. Phelps

The many honors accorded Professor Phelps include a recent award from the American Public Health Association in recognition of his "outstanding achievements across the years for the public health." A memorial fund, just established in his honor at the University of Florida, will be used to support scholarships and research in advancing the work to which he devoted his life.

Steel Joist Institute Names Its 1953–1954 Officers

At the recent annual meeting of the board of directors of the Steel Joist Institute the following officers were reelected: A. Carl Weber, A. M. ASCE, St. Louis, Mo., president; James D. Maitland, Denver, Colo., vice-president; and C. H. Luedman, Washington, D.C., secretary-treasurer. J. W. Hubler, M. ASCE, chairman of the civil engineering department at Washington University, St. Louis, was reappointed consulting engineer for the Institute.

N. G. Neare's COLUMN

R. Robinson Rowe, M. ASCE

"I can hardly wait," said Professor Neare, "to tell you of an amusing incident at our Engineers' Club Picnic last Saturday, so please, Joe, tell us quickly how Al E. Dayde fared in his deal at Bell-Lee Acres."

"He did OK," replied Joe Kerr, "but I'm not sure of the degree of OK-ness. Of the 360 lots, he received all those with numbers divisible by 3, but numbers were not consecutive because of previous sales. He received the 72 divisible by 9 and the 90 divisible by 6 and probably 40 of the 120 divisible by 5, which adds to 202. This has to be corrected for lot numbers like 90, which is divisible by 5, 6 and 9, and numbers like 93, which isn't, but these numbers tend to offset each other. Anyway, 202 is a lot more than the 120 offered, so I'm sure Al did OK."

"The question," scoffed Cal Klater," was *not* how Al might have done, but how he *probably* did. Divisibility by 5 is irrelevant; the other data can be analyzed by grouping the 360 lot numbers according to their remainders when divided by 18.

Group	Number	Deviation	Probable
0	$14y - 198$	$14y - 218$	40
1	y	$y - 20$	17
2	y	$y - 20$	17
3	y	$y - 20$	17
4	y	$y - 20$	17
5	y	$y - 20$	17
6	$-7y + 144$	$-7y + 124$	25
7	y	$y - 20$	17
8	y	$y - 20$	17
9	$-14y + 270$	$-14y + 250$	32
10	y	$y - 20$	17
11	y	$y - 20$	17
12	$-7y + 144$	$-7y + 124$	25
13	y	$y - 20$	17
14	y	$y - 20$	17
15	y	$y - 20$	17
16	y	$y - 20$	17
17	y	$y - 20$	17
Totals	360	0	360

"In the table, Col. 1 identifies each group by its remainder and Col. 2 expresses the number of lots in the group in terms of a variable, y, selected as the probable number in each group for which no data was given. Note that $G_0 + G_9 = 72$ and $G_0 + G_6 + G_{12} = 90$ as required by divisibility by 9 and 6. Had the distribution been equitable, there would have been 20 in each group; Col. 3 shows the deviation from 20. To minimize the sum of the squares:

$$S = (14y - 218)^2 + (250 - 14y)^2 + 2(124 - 7y)^2 + 14(y - 20)^2$$

$$\frac{dS}{dy} = 28(14y - 218) - 28(250 - 14y) - 28(124 - 7y) + 28(y - 20) = 0$$

$$y = 17$$

"The last column shows the probable number in each group, from which the number divisible by 3 is $x = 40 + 17 + 25 + 32 + 25 + 17 = 156$."

"Which is a 30 per cent bonus for hossense," declared the Professor. "Now, as I was saying about the picnic, we had set up 6 long tables parallel to one another, and Titus Wadhouse, noticing that spacing was haphazard, started moving one at a time trying to equalize them. Usually an efficiency engineer, he surely took the day off, shuffling the tables by successive approximations, slowly converging on equalization until he tipped over a pitcher of lemonade and the ladies shooed him. Had the spaces been, in order, 10, 16, 8, 11 and 15 ft, what is the most he would have had to move any table?"

[*Cal Klaters were: Flo Ridan (Charles G. Edson), Abbot Sackheim, Rudolph W. Meyer, Thatchrite (Guy C. Thatcher), Sauer Doe (Marvin Larson) and Stoop (John L.) Nagle.*]

DECEASED

Alexander Seymour Ackerman (M. '22), age 73, retired colonel in the Corps of Engineers, Newport, R.I., died on June 22. A member of the Corps since 1905, Colonel Ackerman held posts in Detroit, Philadelphia, Pittsburgh, Sacramento, and Fort Belvoir and Fort Humphreys, Va. From 1915 to 1917 he was in private practice and worked for Merck & Co., Rahway, N.J.

Henry James Alexander (M. '24), age 78, retired civil engineer of Rockport, Mass., died at his home on May 8. Mr. Alexander worked for the New York City Board of Transportation on subway construction continuously from 1901 until his retirement in 1934. He was an alumnus of Harvard University, class of 1900.

Eugene Yorke Allen (M. '20), age 75, retired chief engineer of the Reading Co., Philadelphia, Pa., died on May 4. In railroad engineering since 1914, Mr. Allen was connected with the Reading railway from 1920 to 1946, serving at various periods as valuation engineer and assistant chief engineer. He graduated from Princeton University in 1899.

Wade Vance Baise (M. '52), age 56, executive director and treasurer of the Carolina Asphalt Association, Raleigh, N.C., died at his home in that city on June 13. Formerly on the staff of the North Carolina State Highway and Public Works Commission, Mr. Baise was chief engineer from 1935 to 1949. He was educated at Mars Hill College and North Carolina State College.

Ivan Wilmot Barber (A.M. '31), age 55, since 1942 a civilian employee with the Geology, Soils, and Materials Division of the Missouri River Division of the Corps

Please supply all information requested before September 30, 1953.

FOR ASCE MEMBERSHIP DIRECTORY

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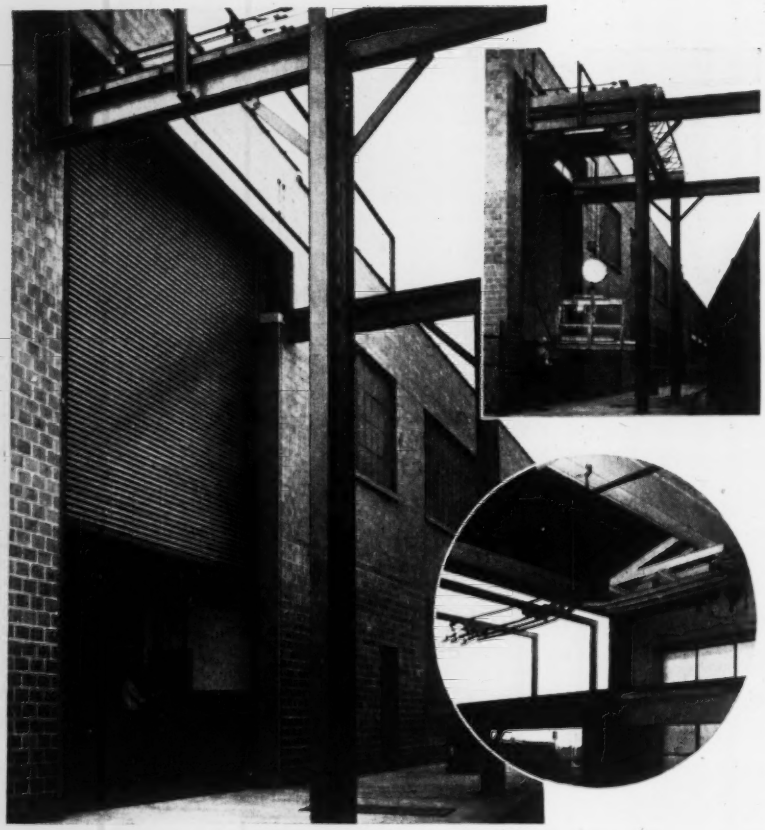

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of Engineers, died in Omaha, Nebr., on June 9. After graduation from the Texas Agricultural and Mechanical College, Mr. Barber began a ten-year association with the Western Laboratories of Lincoln, Nebr., as testing engineer. From 1934 to 1940 he was employed by the Platte Valley and Central Nebraska public power and irrigation districts.

Theodore Bloecher, Jr. (M. '22), age 76, assistant office engineer with the Baltimore & Ohio Railroad, Baltimore, Md., died at his home in that city on June 12. Continuously connected with the railroad since 1911, Mr. Bloecher served as assistant division engineer, division engineer and special engineer at Philadelphia, Wheeling, and Baltimore. Earlier he was employed for nine years on the Erie and other railroads. Mr. Bloecher was an alumnus of Cooper Union.

Edward Gilman Carey (M. '20), age 76, chief engineer and vice-president of the George W. Rogers Construction Corp., New York, N.Y., died while on vacation at Wilmington, Vt., on June 29. Before joining the Rogers Corporation in 1924 Mr. Carey was associated with the Empire Construction Co., Baltimore, Md. He studied at the Massachusetts Institute of Technology.

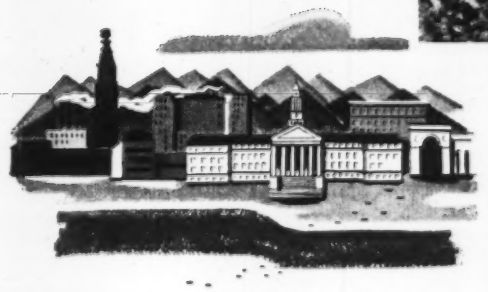
William Harper Chorlton (M. '18), age 71, consulting engineer with General Industries Inc., since his retirement as professor of structural engineering at the University of Pennsylvania, died in Philadelphia, Pa., on June 21. An alumnus of the University, Professor Chorlton joined the faculty in 1923, and served continuously until his retirement. From 1902 to 1923 he had been associated with the American Bridge Company in Philadelphia and New York. Professor Chorlton designed the Kill Van Kull Bridge between Staten Island, N.Y., and Bayonne, N.J.

Charles Fred Duchscherer (M. '44), age 65, retired vice-president of the R. S. McMannus Steel Construction Company, Inc., Buffalo, N.Y., died there on June 16. Mr. Duchscherer was associated with the company for more than 30 years, retiring in 1952. Recently he was connected with the engineering concern of Duchscherer & Oberst. He was a graduate of Union College, class of 1911.

Nathan Stone Emery (A.M. '43), age 46, consulting engineer for the Radar Engineering Co., Miami, Fla., died on February 25. Mr. Emery joined the Florida State Road Department as an instrumentman in 1925, advancing to division engineer at Ft. Lauderdale in 1941—a position he held for seven years. He was then connected with several Florida engineering and contracting companies.

Carl Alvord Gould (M. '35), age 69, consulting engineer of Denver, Colo., and an alumnus of Cornell University, died at his home in Denver on March 27. In the U.S. Forest Service from 1931 until his retirement in 1950, Mr. Gould was regional engineer in charge of the Division of Engineering at the Denver office for several years. Earlier he was engaged in private engineering and contracting work, and was employed

Denver Prefers Concrete Pressure Pipe



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by the Northern Pacific Railroad. He served as president of the Colorado Section for the 1950–1951 term.

Cyrus Pierce Howes (A.M. '14), age 71, retired railroad bridge engineer, died at his home in Dallas, Tex., on June 6. Following service in World War I, Mr. Howes began working for the Texas & Pacific Railway as a bridge engineer in 1919 and served continuously until his retirement in 1952. He was a graduate of the Massachusetts Institute of Technology.

Edward Hutchins (A.M. '10), age 75, consulting engineer of Carmel, Me., died at his home in that city on May 30. After more than 37 years of continuous service with the International Paper Co., Mr. Hutchins retired in 1949 as plant engineer of their Hudson River Mill at Corinth, N.Y. Earlier he had been employed by H. S. Ferguson at Millinocket, Me., and F. W. Bird and Son, East Walpole, Mass. He attended Worcester Polytechnic Institute.

Frank Hutchinson (M. '17), age 78, retired mining engineer of Duluth, Minn., died at his home on January 5. From 1918 to 1946 Mr. Hutchinson maintained a private consulting practice with headquarters at Duluth. During his career he had engaged in extensive ore studies in China, Manchuria, Mexico, and Russia, as well as in the United States. He attended the University of Illinois.

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Street.....

City.....State.....

Arne Arthur Jakkula (M. '42), age 49, since 1946 executive director of the Texas Agricultural & Mechanical Research Foundation, died at College Station, Tex., on May 30. He was an alumnus of the University of Minnesota. Before entering the research field, Professor Jakkula served on the faculties of the University of Michigan (1928–1937) and Texas A. & M. (1937–1944). Widely known for his research work, he was author of several books and co-author of the recently published *Fundamentals of Structural Analysis*.

Scott Keith (M. '30), age 55, a partner in the engineering firm of Metcalf & Eddy, of Boston, died suddenly at his home at Newton Highlands on July 4. A specialist in water supply engineering and hydraulics, Mr. Keith had been with the firm since 1920. During World War II he was chief engineer for its New York office at the time of the designing of the Bermuda Army Air Base. He was a graduate of Harvard and M. I. T. in 1919. At the time of his death he was a director of the New England Water Works Association.

Donald Leroy Kirsch (J.M. '52), age 31, junior engineer with Edward L. Varney & Associates of Phoenix, Ariz., died in Prescott, Ariz., on June 2. A June 1952 graduate of the University of Colorado, Mr. Kirsch was in the Air Force during World War II for a period of three years.

John Harold MacKinnon (A.M. '21), age 60, president of Gest & MacKinnon, Inc., New York, N.Y., died on February 28, 1952. After graduating from Massachusetts Institute of Technology, he was employed by Monks & Johnson and Gascoigne & Linenthal, Builders, both of Boston, Mass., and Charles Shongood, New York City. In 1930 Mr. MacKinnon became associated with G. M. Gest of New York, and later entered into a partnership with him.

Glenn Davis Macy (M. '32), age 63, consulting engineer of Santa Fe, N. Mex., died on May 12. From 1923 to 1940, he served continuously with the New Mexico State Highway Department in such capacities as district and state highway engineer, inspector, and right-of-way engineer. Previously he had been chief engineer for the Canada Copper Corp., and construction superintendent for the Goodrich-Lockhart Co., Valley Ranch, N. Mex. Mr. Macy attended Ohio State University.

Charles Hatton Mercer (M. '01), age 89, of Bethlehem, Pa., in retirement since 1943, died on May 4. During his long career, Mr. Mercer was assistant and chief engineer for the Pennsylvania Steel Co., Steelton, Pa. (1899–1916), and chief engineer for the Bethlehem Steel Bridge Corp., and the Bethlehem Steel Co., Bethlehem, for a period of 15 years. For several years he acted as consulting engineer for the McClintic-Marshall Co., and the Fabricated Steel Division of the Bethlehem Steel Co.

Spencer Miller (M. '94), age 94, retired engineer of Laguna Beach, Calif., and South Orange, N.J., died at Fort Myers, Fla., on June 16. Mr. Miller was the last surviving member of the class of 1879 of Worcester Polytechnic Institute, and the second oldest member of ASCE in point of affiliation, having joined the Society as an Affiliate in

1889. While associated with the Lidgerwood Manufacturing Co., of New York (from 1886 until his retirement in 1926), Mr. Miller patented several inventions in the field of hoisting and conveying materials. For many years he maintained a consulting office in New York City.

Edward Fuller Miner (M. '08), age 91, retired engineer of Worcester, Mass., and alumnus of the Worcester Polytechnic Institute, class of 1887, died on June 6. Mr. Miner was president of the Edward F. Miner Building Co., Worcester, for 21 years; president of the Central Building Co., for nine years; and an engineer for the Norcross Bros. Co., for 16 years.

Gordon Vernon Nelson (A.M. '45), age 55, senior partner in the Kansas City (Mo.) firm of Nelson, Beggs & Eidson, died on June 5. Before entering private business in 1945, he had been connected with the Standard Oil Co., the Great Lakes Pipe Line Co., Jones-Hettelsater Construction Co., Horner and Wyatt, and the J. F. Pritchard Co. Mr. Nelson received both the bachelor of science and master of science degrees from the University of Illinois.

Sam Ab Nixon, Sr. (A.M. '33), age 52, design engineer for the Regional Design and Construction Division of the U.S. Soil Conservation Service, Fort Worth, Tex., died in that city on June 3. In government service for over 20 years, Mr. Nixon held various positions on conservation projects throughout Texas. He received the bachelor of science and master of science degrees in civil engineering from Texas Agricultural & Mechanical College.

Alfred Peter Poorman (M. '26), age 75, professor of applied mechanics at Purdue University, died on February 12, 1952. A member of the Purdue faculty since 1919, Professor Poorman previously taught at the University of Colorado for two years. He was an alumnus of the University of Illinois and the University of Colorado, and the author of *Applied Mechanics* and *Strength of Materials*.

Forrest Allen Pruitt (M. '20), age 70, vice-president and contracting manager of the Hughes-Foulkrod Co., of Philadelphia, Pa., with which he had been associated since its founding in 1916, died in that city on June 4. For many years he served as manager of the firm's office in Pittsburgh. Earlier he was employed by the Pennsylvania and the Michigan Central railroad companies, and the McClintic-Marshall Co. He was a graduate of the University of Illinois.

Leroy Leland Schmucker (A.M. '32), age 51, chief engineer for the Clemmer Construction Co., Inc., of Akron, Ohio, died on October 8, 1952. Before joining the Clemmer company in 1947 as an estimator he had been employed by the Carmichael Construction Co., of Akron, and the Baltimore & Ohio Railroad, for several years. He was an alumnus of the University of Akron.

Owen Zelotes Wrenn (A.M. '21), age 64, since 1948 president of the Wrenn-Wilson Construction Co., of Durham, N.C., died on June 25. In 1914, after graduation from North Carolina State College, Mr. Wrenn was employed by several North Carolina engineering firms and for ten years headed a steel and iron products firm in Charlotte.

NEWS OF ENGINEERS

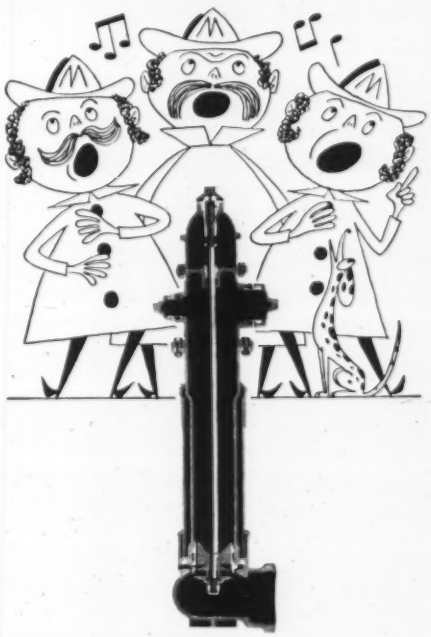
Carlton S. Proctor, president of the New York engineering firm of Moran, Proctor, Meuser and Rutledge, and immediate Past-President of ASCE, was recently elected a member of the Princeton University board of trustees. Mr. Proctor, a member of the class of 1915, will serve a four-year term as alumni trustee-at-large. He is the first engineer to be named to the board.

Ellis L. Armstrong, on a four-month leave from his Bureau of Reclamation post as construction engineer in charge of Trenton Dam, Nebr., is now serving as a member of a twelve-man Technical Cooperation Administration commission working with the Egyptian government on plans for community development and rural rehabilitation. Mr. Armstrong, who has been engaged in irrigation development work for 20 years, is engineering consultant to the commission.

Harvey O. Banks has been promoted from supervising hydraulics engineer with the California State Division of Water Resources, at Sacramento, Calif., to assistant state engineer in charge of water-rights administration.

Morton O. Withey, dean of the college of engineering at the University of Wisconsin, and a member of the faculty since 1905, has retired. After graduating from the Thayer

Installed in Grandfather's Day— Still Providing Full Community Protection



MATHEWS HYDRANTS

Made by R. D. Wood Company

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

• Mathews Hydrants are built to last. They are so simple and well constructed that there's virtually nothing to go wrong.

• Maintenance is easy, too. Operating thread can be lubricated during spring and fall inspections.

• When the time comes to modernize, it is a simple matter to remove the old barrel and replace it with a modern one. The job is done in a few minutes without digging or breaking the pavement.

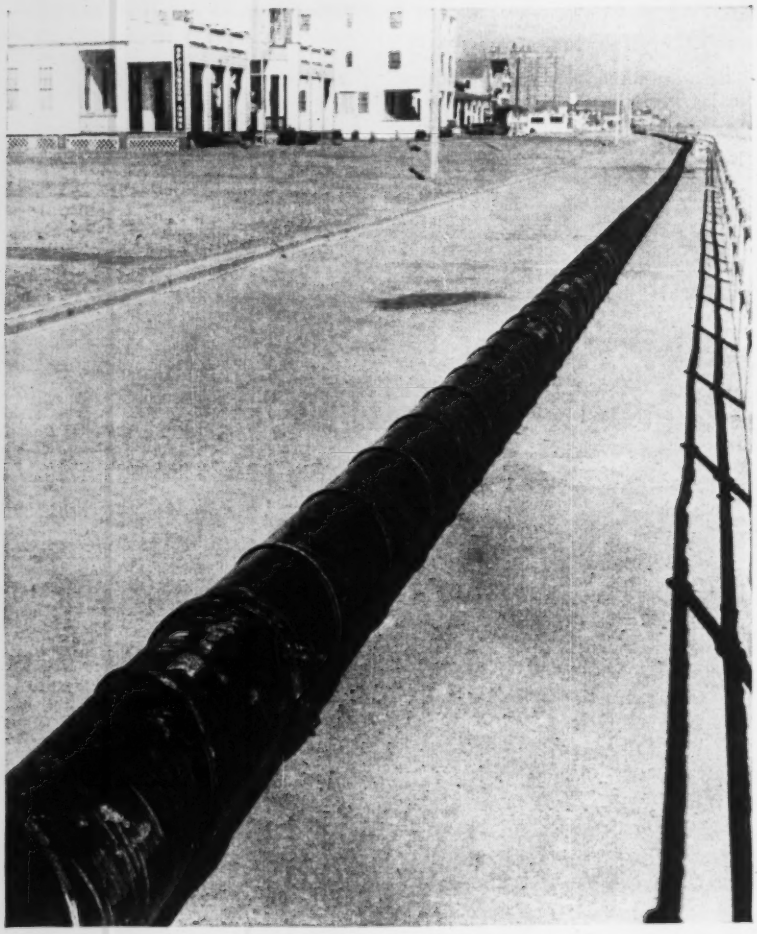
No Other Hydrant Offers So Many Essential Features

Compression type valve prevents flooding • Head turns 360° • Replaceable head • Nozzle sections easily changed • Nozzle sections easily raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for strength, toughness, elasticity • Operating thread only part to be lubricated • All working parts contained in removable barrel • A modern barrel makes an old Mathews good as new • Available with mechanical-joint pipe connections

150th anniversary

NAYLOR PIPE...

Gets around wherever you need it



You can always depend on this distinctive extra-strong lightweight pipe to carry the load—whether it's for high or low pressure air or water lines, ventilating, dredging, hydraulic sluicing or other service. It's easy to handle and install—especially with Naylor Wedge-Lock couplings to speed connections. Sizes from 4 to 30 inches in diameter. Write for Bulletins No. 507 and 513.

NAYLOR PIPE COMPANY
1281 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, New York

School of Engineering, Dartmouth College, he went to the University of Wisconsin as an instructor in mechanics, advancing to chairman of the department in 1934, and dean of the engineering faculty in 1946.

Frank W. Edwards will be in charge of a new office which the Stanley Engineering Co., of Muscatine, Iowa, will open in Chicago in the Utilities Building, 327 La Salle Street. Since 1948 Mr. Edwards has been director of civil engineering at the Illinois Institute of Technology. On temporary leave, he was general manager of the Centennial of Engineering held in Chicago in 1952. Prior to his association with the Illinois Institute of Technology, his experience included teaching at Carnegie Institute of Technology and at Pennsylvania State College and a number of years with the U.S. Engineers with major responsibility on design of civilian and military projects.

© Koehne
Frank W. Edwards

Edward F. Blake has advanced from the position of vice-president and chief engineer of the McLean Contracting Co., Baltimore, Md., to the presidency.

D. J. Bleifuss recently resigned as vice-president and director of engineering of the International Engineering Co., Inc., of San Francisco, Calif., to engage in private practice.

Joseph B. Brooks, consulting engineer of St. Louis, B.S. in C.E., Washington University, 1942, received the professional degree of civil engineer from the university on June 10. The subject of his thesis was "The Role of the Consulting Engineer in Right-of-Way Condemnation."

Berry E. Brevik, general field engineer with the Portland Cement Association, assigned to the Fox River Valley, was recently honored at a testimonial dinner for 25 years of service with the association. Mr. Brevik is a past-president of the Wisconsin Section.

Willian N. VanKoughnet has been promoted from project engineer to engineer in charge of yardwork and surveys with the Libbey-Owens-Ford Glass Co., Toledo, Ohio. He has been with the Libbey company since 1945.

Francis Seeley Foote was among seventeen retiring faculty members of the University of California staff at Berkeley honored at the annual Commencement Day Alumni Luncheon on June 19. Professor Foote joined the staff in 1912 as associate professor of railroad engineering becoming professor in 1917.

C. A. Harrell has been named chairman of a new department, set up by the Southwest Research Institute, San Antonio, Tex. Mr. Harrell, an authority on city manage-

ment and industrial development, has been serving as city manager for Norfolk, Va.

James B. Hays, who is currently in charge of the construction of six saddle dams and a spillway on the Nechako-Kittamat project for the Aluminum Company of Canada, in British Columbia, was awarded the honorary degree of doctor of science by the University of Idaho on June 7.

John M. Henderson has returned to Savannah, Ga., after a three-month visit to India, under the auspices of the Technical Cooperation Administration, where he served as malaria control consultant on the water resources development of the Damodar Valley Corp., and on the national malaria control program. Mr. Henderson is now engaged as deputy chief, technical development laboratories, Communicable Disease Center, U.S.P.H.S. at Savannah, and as consultant to Technology Branch Headquarters, Civil Defense Corps, Atlanta, Ga.

Howard, Needles, Tammen & Bergendoff, consulting engineers of Kansas City and New York, announce the removal of their Kansas City office to the Grand Avenue Bank Building, 1805 Grand Avenue, Kansas City 8, Mo.

Clarence D. Howe, Minister of Trade and Commerce and Minister of Defense Production of Canada, received the honorary degree of doctor of engineering at Northeastern University's 54th annual commencement exercises on June 21. He was cited as "Engineer, executive, and statesman extraordinary . . ." who has distinguished himself ". . . as a dynamic, forthright individual who makes himself the servant of the people and devotes his energies to the well-being of the state." Mr. Howe was 1952 recipient of the Hoover Medal.

George W. Housner has been promoted from assistant to full professor of civil engineering and applied mechanics at the California Institute of Technology. A member of the Caltech staff since 1945, Professor Housner worked with the U.S. Army Engineers and the Army Air Force during the war on structural engineering and exterior ballistics problems, and received the A.A.F. award for exceptional civilian service.

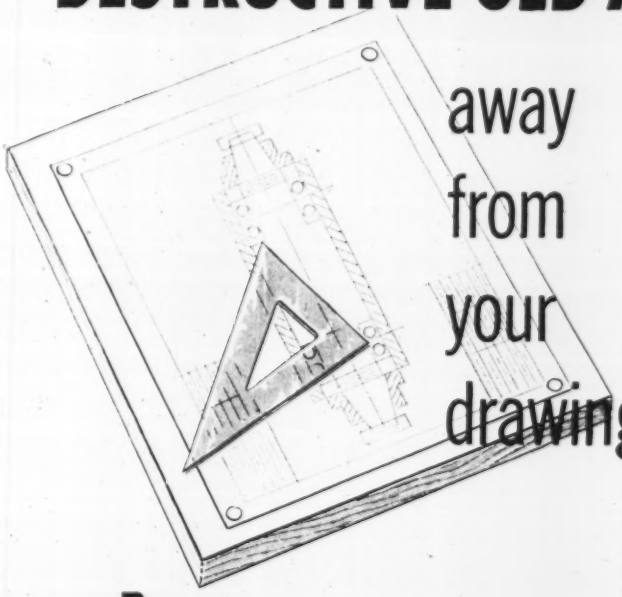
Alfred D. Yanda announces the opening of offices for the practice of civil engineering at 1900 Euclid Avenue, Cleveland, Ohio.

Carlo Semenza, manager of hydraulic construction of Societa Adriatica de Elettricita (S.A.D.E.) of Venice, Italy, was recently awarded the Telford Gold Medal by the British Institution of Civil Engineers for the excellence of his paper "The Most Recent Dams (5) by the S.A.D.E. in the Eastern Alps." The paper describes the characteristics and methods of construction of these arch and dome-type dams being completed under his direction on the Piave River system. Since 1919 Mr. Semenza has

Carlo Semenza

Keeps

DESTRUCTIVE OLD AGE



away from your drawings

BY the time you discover old age has attacked your important drawings — it's too late. By then, the damage has been done. The time to effectively block old age is NOW — while tomorrow's drawings are still in the preparatory stage.

The way to do it? Specify Arkwright Tracing Cloth. Arkwright checks the destructive effects of old age. Arkwright won't fray at the edges, turn brittle or opaque. You are assured perfect transparency, regardless of age.

There are other reasons why it pays to work with Arkwright. This superior tracing cloth can "take" all the erasing you're likely to give it in a month of Sundays — and still provide sharp, clear lines. You need never worry about "feathering" or "blobbing" or imperfect blueprints.

So insist on quality. You'll get it with Arkwright . . . America's Standard for over 32 years. Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

ARKWRIGHT
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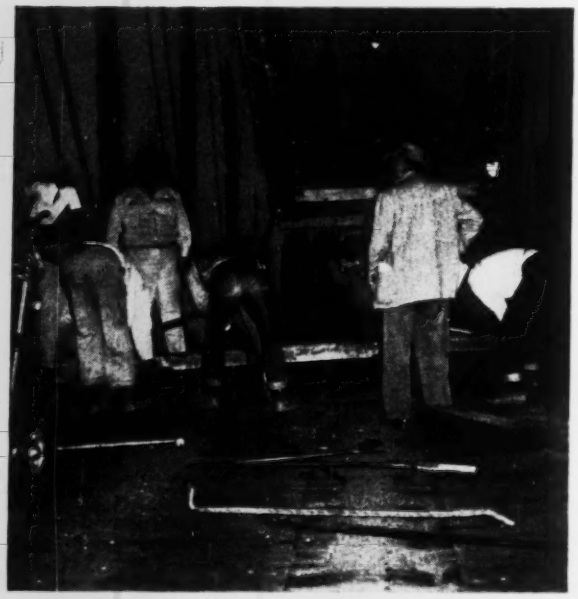
AMERICA'S STANDARD FOR OVER 32 YEARS

Reflooring old bridge with saves 131,345



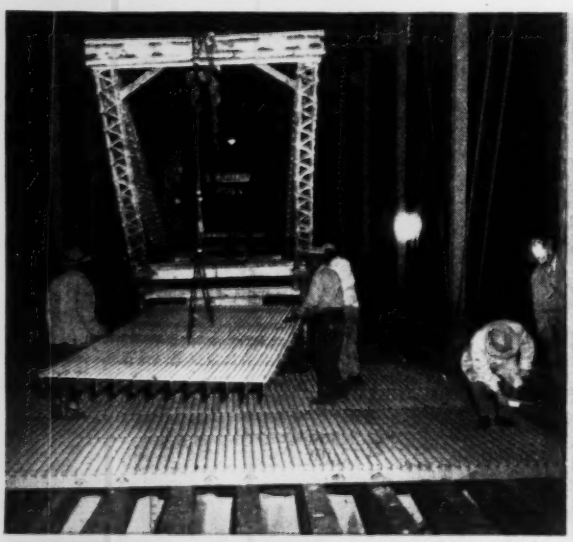
THE OLD FLOOR SYSTEM consisted of 6" x 14" wood stringers, 3" wood decking and four lines of ¼" x 30" steel tread plates. Crew is shown removing the outdated floor in preparation for new I-Beam-Lok lightweight steel flooring.

● From the Louisiana State Department of Highways comes another interesting example of the use of I-Beam-Lok on a modernization job.

The project was the reflooring of the 18′ roadway of the 767 ft. long Alexandria-Pineville bridge over the Red River in Rapides Parish. The old timber floor was difficult to maintain under the increasingly heavy traffic.

The problem involved finding a suitable flooring that would not add to the deadweight of the supporting structure, yet would be more permanent, and require less maintenance than the existing floor. U·S·S I-Beam-Lok open steel flooring met all requirements.

The engineers estimate that the new floor system including steel stringers, 14,856 sq. ft. of 5″ I-Beam-Lok, steel curbs and concrete fill over the pivot pier weighs only 502,914 lbs. for the entire bridge. Compared with a total weight of 634,259 lbs. for the old floor system it replaced, the savings in weight through the use of I-Beam-Lok is 131,345 lbs.



THIS PHOTO SHOWS temporary positioning of a few I-Beam-Lok units on present wood stringers to allow traffic to flow on following morning. These units to be lifted later for installation of permanent steel stringers on which I-Beam-Lok units are to be permanently welded.

BRIDGE WAS KEPT OPEN to traffic each day from 6:00 a.m. to 10:00 p.m. Vehicles moved safely over the newly laid I-Beam-Lok without interruption as all construction work was done late at night.

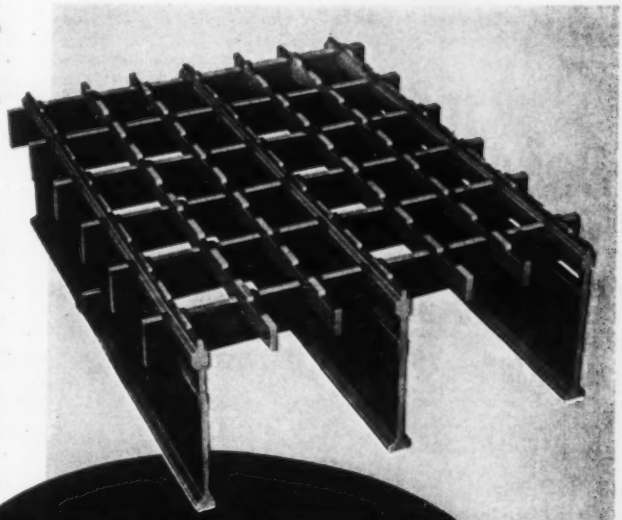
PROJECT: Reflooring of Alexandria-Pineville (Red River) bridge on Routes 5 and 14 in Rapides Parish, Louisiana.

ENGINEERS: State of Louisiana Department of Highways. J. B. Carter, Bridge Design Engineer, Baton Rouge, Louisiana.

CONTRACTORS: Forcum-James Company, Baton Rouge, Louisiana.

U·S·S I-BEAM-LOK

lbs. deadweight



KEPT OPEN TO TRAFFIC

Another important advantage gained through the use of I-Beam-Lok was that the busy bridge was kept open to traffic each day from 6:00 a.m. to 10:00 p.m. while the new flooring was being installed at night.

Available in units measuring 6′-2″ in width and up to 49′ in length, this lightweight, all-steel open flooring with its strong, full 5″ depth can be applied directly to stringers on spans up to 4′ centers to permit H-20 loadings. It does not require secondary supports.

This "modern floor for modern traffic" combines lightweight and reduced costs with roadway rigidity, ease of erection, a smooth, hard surface and low maintenance costs. It is available in both concrete-filled and open types. Our engineers will be glad to discuss its possibilities with you. For more information about U·S·S I-Beam-Lok steel flooring, contact the sales office nearest you.

U·S·S I-BEAM-LOK

the lightweight, long-life flooring for modern traffic

SECTIONS OF NEWLY LAID I-BEAM-LOK were speedily welded together with ordinary field equipment. This lightweight steel open flooring produces a smooth-riding, non-skid, self-cleaning and long-wearing surface.

THIS OVERHEAD VIEW of the newly refloored bridge shows the clean open pattern of U·S·S I-Beam-Lok.

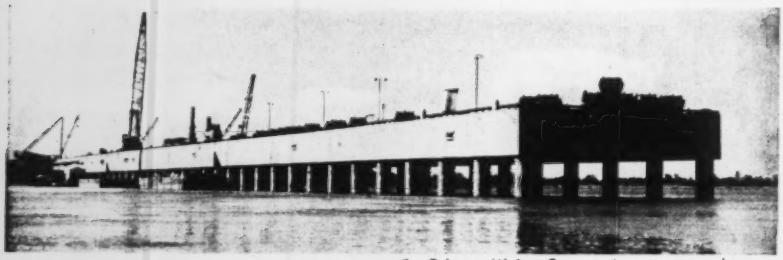
UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S I-BEAM-LOK

USS

3-1089

UNITED STATES STEEL



1. Orinoco Mining Company's new ore and cargo handling dock on the Orinoco River, Venezuela. Composed of 3 units, this DeLong dock is 1,130 ft. long, 82 ft. wide, and 15 ft. deep.

DeLong AIRJACK TRANSFORMS SEA-GOING DOCK-BARGE INTO ORE AND CARGO PIER!

Cuts time, costs!

Field work is practically eliminated in dock construction, due to the development of the patented DeLong Airjack. This new technique of dock construction speeds installation, cuts costs.

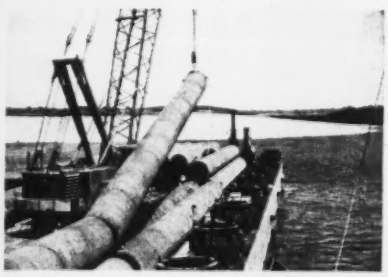
The DeLong Airjacks, which are the key to the whole transformation of barge to pier, enable the dock to "climb" the steel columns, or caissons, to required elevation. After the self-lifting operation, caissons are driven to refusal for permanent installations. Caissons are welded to deck and cut off flush; then filled with concrete or sand and tops closed with welded cover plate.

More than ½ million sq. ft. of the DeLong type of pier are in use or under construction in diversified locations that range from the Arctic to South America.

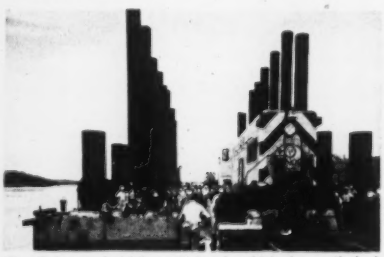
The DeLong Airjack can cut time and costs in the construction of offshore oil well drilling platforms, portable and permanent piers, and many other types of installations. A DeLong dock can be erected and, after having served its purpose, jacked back to water level and towed to a new location.

2. A week after arrival at Orinoco River site, first dock section 376 ft. long berths ship, and unloading begins. Two additional units make this pier 1,130 ft. long.

3. Loaded dock section, fabricated at an Orange, Texas yard, arriving at site on Orinoco River, after being towed across 3,000 miles of ocean. Dock carried caissons, crane, Airjacks, compressors, generators, other installation gear.



4. Crane placing 6 ft. diam., 100 ft. long steel caissons in wells fitted with Airjacks. Crane, Airjacks and other equipment were later transferred to second and third sections for erection purposes.



5. Caissons held in position by Airjacks until dock barge is jockeyed into final position. Caissons are then dropped to river bottom and DeLong Airjacks lift dock to final elevation. Control is so precise, height of dock can be regulated to 1/32 of an inch.

DeLong
Engineering & Construction Co.
29 BROADWAY, NEW YORK 6, N. Y.
Phone: HAnover 2-1275

WASHINGTON 5, D. C.	SEATTLE, WASH.	CARACAS, VENEZUELA	SAN FELIX, VENEZUELA
729–15th St., N. W.	32nd Floor, Smith Tower	Apartado 968	

had full responsibility for the design and construction of hydro plants for S.A.D.E. He is a member of the Italian Commission of the International Commission on Large Dams.

Charles W. Yoder has opened an office as a consulting structural engineer at 2571 North 84th Street, Milwaukee, Wis. He has been district structural engineer with the Portland Cement Association at Milwaukee and previously was with the Pennsylvania Railroad and the Bethlehem Steel Corp., as a structural engineer. Active in Society affairs, Mr. Yoder is a past-president of the Wisconsin Section.

Charles W. Yoder

A. H. Fuller, since 1920 professor of civil engineering at Iowa State College, was presented with a Faculty Citation at the annual Alumni Day celebration on June 13. The award is presented to outstanding members of the staff who have been associated with the college for a minimum of 15 years. Before going to Iowa State Dr. Fuller was dean of engineering at the University of Washington (1899–1917) and professor of civil engineering at Lafayette College (1917–1920).

Frank J. Haight retired on June 30 as oceanographer with the Division of Tides and Currents, Coast and Geodetic Survey, after more than 32 years of service. He has served as chief of the Division's section of currents since 1937. Mr. Haight was the recipient of the Department of Commerce Meritorious Service Award in 1951.

Walter C. Voss, head of the department of building engineering and construction at the Massachusetts Institute of Technology since its reestablishment in 1940, is retiring this summer. He will continue to lecture on part-time duty next year. Professor Voss joined the M.I.T. faculty in 1928 as associate professor in the department of building construction and in 1931 advanced to professor.

Francis H. Bulot has been named president of a newly established organization—Francis H. Bulot, Consulting Engineers, Inc.—which will maintain offices in Los Angeles, Pasadena and Costa Mesa, Calif. Mr. Bulot has been practicing as a consulting engineer in California for more than 30 years. Associated with the company are **John T. Robinson** and **Kenneth Brunner.**

Arthur C. Nauman, until recently in the Office of the Secretary of Defense, Washington, D.C., with the military liaison committee to the Atomic Energy Commission, assumed the post of district engineer of the Detroit District, U.S. Army Engineers, on July 1.

Walter L. Huber, ASCE President, has been appointed to membership on the Advisory Board on National Parks, Historic Sites, Buildings and Monuments of the National Park Service. President Huber is an honorary vice-president of the Sierra Club, an organization devoted to conservation, mountaineering and kindred subjects, has always had an active interest in matters of preservation of regions of scenic and historic interest.

L. H. Oppenheim, of Oakland, Calif., has been named a vice-president of the Henry J. Kaiser Co. Mr. Oppenheim, who joined the Kaiser organization in 1938, will also continue to serve as assistant general manager of Kaiser Engineers, a division of the parent firm.

Edmond H. Leavey has been elected president of Federal Telecommunication Laboratories, Inc., research association of the International Telephone and Telegraph Corp. General Leavey (U.S. Army, retired), has been vice-president of I. T. & T. since 1952.

William S. Lohr, head of the department of civil engineering at Lafayette College, is retiring after 36 years on the faculty there, and will reside in East New Market, Md.

Lester Long, vice-president in charge of sales and secretary of the American Cast Iron Pipe Co., Birmingham, Ala., retired in July after 38 years of continuous service.

Inge Lyse has just completed a 17-month assignment for UNESCO at Kharagpur, India, preparing plans for a new department of civil engineering at the Indian Institute of Technology. Dr. Lyse is returning to his professorship at the Norwegian Institute of Technology at Trondheim.

Gustave Magnel, professor at the University of Ghent in Belgium and international authority on prestressed concrete, recently represented ASCE at the celebration of the one hundredth anniversary of the Technical School of Lausanne.

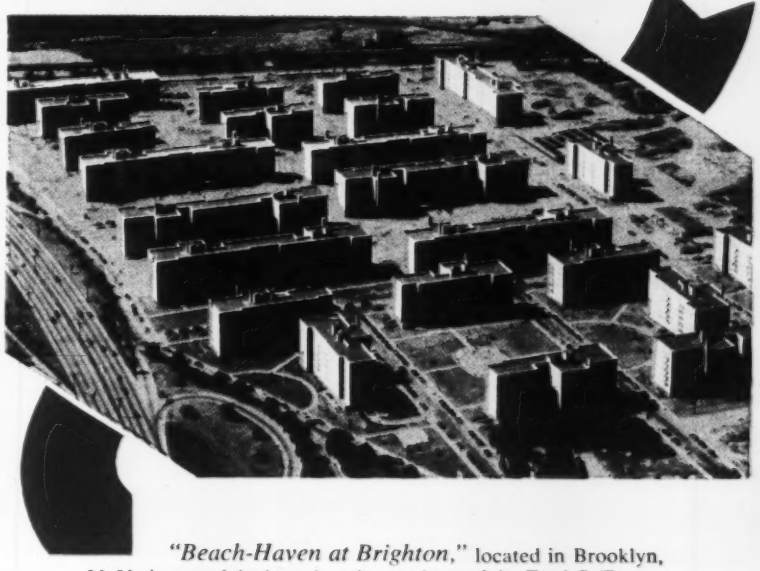
Arthur E. Morgan, first chairman of the Tennessee Valley Authority, has been engaged by the Gold Coast government as an adviser on the Volta River aluminum production project. Dr. Morgan has recently been serving as president of Community Service Inc., at Yellow Springs, Ohio.

Charles A. Emerson, partner in the New York and Cleveland firm of Havens and Emerson, received the honorary degree of doctor of science from his alma mater, Beloit College, in the past commencement season. Mr. Emerson is the great-grandson of the first settler of Beloit and grandson of one of the college's first professors. The citation honored him for a career ". . wrought in sound engineering works for the comfort and health of man. . . ."

Charles A. Emerson

9,000

Koppers Pressure-Creosoted Piles Support 31 Six-Story Apartment Buildings



"Beach-Haven at Brighton," located in Brooklyn, N. Y., is one of the huge housing projects of the Fred C. Trump Construction Company of Brooklyn. It consists of 31 six-story housing units, providing 1,860 individual apartments of 2, 3½ and 4½ rooms. The Trump Construction Company writes, "We have driven close to 10,000 creosoted piles on our Beach-Haven project . . . length 30 to 50 feet, with an average of 38 feet depth driven, at a cost of approximately $700,000. We are pleased to advise however that a very substantial saving was effected by using Koppers pressure-creosoted wood piles over any other form of pile."

Engineers will tell you that Koppers Pressure-Creosoted Foundation Piles are being used on more and more of the industrial and commercial "big jobs." They insure lasting protection against termites, fungi, and acids in the soil. They are readily available at Koppers wood treating plants, and actually cost less than other permanent pile material.

For complete details on price and delivery, contact your nearest Koppers office or write:

KOPPERS COMPANY, INC.
WOOD PRESERVING DIVISION

KOPPERS

Pittsburgh 19, Pennsylvania

Samuel J. Pattison, Jr., Michael Dembo, Murray Marks and **John G. Jarnis** received master of science degrees in civil engineering from Northeastern University on June 21. Employed in full-time positions, these men earned their advanced degrees by attending classes in the evenings.

Jack Renner is this year's recipient of the Robinson award, presented annually by the Robinson Clay Products Co., to the University of Akron's most outstanding senior in the college of engineering.

O. T. Illerich has resigned from his position as district structural engineer with the California State Division of Architecture to enter private practice.

Anthony J. Scullen, dean of the school of engineering and architecture at the Catholic University of America for the past 16 years, has relinquished the post, but will remain on the faculty as professor of civil engineering.

Rolf Thorsten Skrinde is now in Saudi Arabia on assigment as a sanitary engineer with the Point 4 mission of the Technical Cooperation Administration. For the past 18 months he had been engaged in research at the Massachusetts Institute of Technology.

The office of **Henry W. Taylor,** Consulting Engineer, announces consolidation of the New York City and Lynbrook (N.Y.) offices at the Keen Building, 151 West Merrick Road, Freeport, N.Y., effective July 1.

Alfred L. Parme has been awarded the Fuertes Graduate Medal of the school of civil engineering at Cornell University, for his work in the preparation of the ASCE Manual of Engineering Practice, "Design of Cylindrical Concrete Shell Roofs," published in 1952. Mr. Parme is on the staff of the structural and railways bureau of the Portland Cement Association in Chicago, Ill. He recently returned from an assignment as consulting engineer on the Kamishiiba Arch Dam on Kyushu Island, Japan.

Alfred L. Parme

Albert B. Rich, formerly senior engineer with Jackson & Moreland of Boston, Mass., has entered into partnership with **Lewis E. Day,** with offices at 48 Park Street, Framingham, Mass.

Calvin O. Schofield, engineer for Gilboy & O'Malley, Architect-Engineers of Scranton, Pa., recently delivered a lecture at the Institute Tecnico De La Construccion Y Del Cemento in Madrid, Spain, on "American Construction Methods and Equipment on Highway and Airfield Construction." For the past year and a half Mr. Schofield has been engaged in advanced and master planning of airfields in Great Britain.

Edwards, Kelcey and Beck, consulting engineers of Newark, N.J., and New York, N.Y., announce that **William L. Hanavan** has been admitted to the firm as a partner and that **Joseph W. Lavin, H. Jack Leonard, Gordon L. Kirjassoff** and **George H. Leland** have been made associates. **Will H. Smith,** previously named an associate, continues in that capacity.

Joseph E. Vollmar, Jr., president of Vollmar Bros. Construction Co., St. Louis, Mo., received the degree of professional engineer in civil engineering from Washington University at the commencement exercises on June 10. The degree represents three years of study and a thesis on the subject of "Docks and Dock Structures on the Upper Mississippi."

Daniel E. Whelan, Jr., who has been on duty as an officer in the U.S. Coast and Geodetic Survey for the past ten years, is returning to Loyola University in Los Angeles as dean of the college of engineering.

Max Weinroth, chief of the airfields criteria section, Directorate of Installations, at the U.S. Air Force headquarters, Washington, D.C., has been ordered to active military service with the grade of lieutenant colonel. He has been assigned as installations staff engineer at Limestone Air Force Base, near Caribou, Me.

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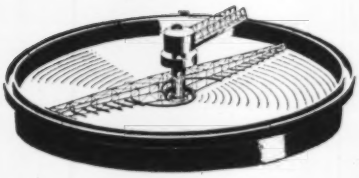

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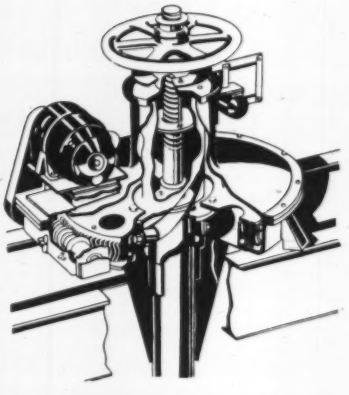

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Welding research . . .

(This article begins on page 29)

(Continued from page 33)

Other Tests for Plastic Design

The entire program at Lehigh University has included tests of columns with combined bending and axial loading to simulate conditions in the vertical members of rigid frames; also tests of continuous beams to determine their capacities for rotation, to form plastic hinges. Two full-scale rigid frames (portal frames with rectangular knees) have been tested virtually to destruction to confirm predictions made by plastic analysis.

In a test of an 8 WF 31 column 16 ft long, with hinged ends and an axial load and bending moment applied at the top, the maximum resistance of the column not only exceeded the predicted yield moment but exceeded the plastic-hinge moment for this beam section subjected to pure bending. This result indicates that in many cases the influence of axial load may be neglected in portal-frame columns when designing by plastic analysis.

The behavior of the beams in these various tests, together with other considerations, leads to a belief that residual stresses due to welding are not usually as influential as those due to cooling after rolling. The welding stresses are highly localized whereas the rolling-mill stresses are widespread and would be expected to cause somewhat premature yielding over a wider area and thus influence deflections.

At least one structure has been designed by the method of plastic analysis, a building for the British Welding Research Association.

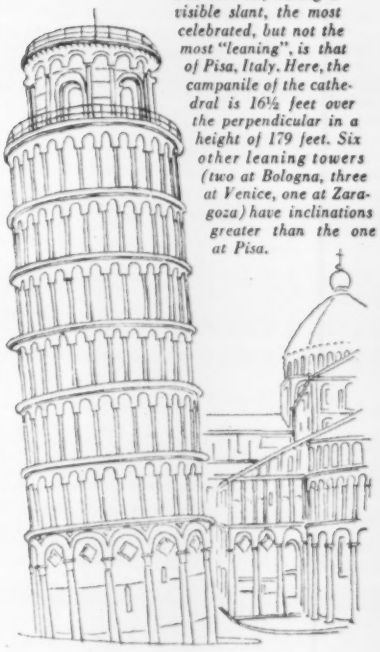
As more thought is being given to resistance to bombing, the matter of reserve strength becomes increasingly important. Whether it is recognized or not in design analysis, experience confirms that welded rigid-frame and continuous construction usually provides a tremendous amount of reserve strength as compared with simple beam and column design.

Research in welding, as in other fields, is never ending. It continues to contribute to our better understanding of the behavior of welded structures and how to design them for best economy and performance.

(This article is an abstract of the paper presented by Mr. Grover before a joint session of the ASCE Structural Division and the American Welding Society, at the Centennial Convention in Chicago. The session was presided over by Raymond Archibald, M. ASCE.)

An interesting slant on Pisa!

Of the many towers which are out of the true vertical, having a visible slant, the most celebrated, but not the most "leaning", is that of Pisa, Italy. Here, the campanile of the cathedral is 16½ feet over the perpendicular in a height of 179 feet. Six other leaning towers (two at Bologna, three at Venice, one at Zaragoza) have inclinations greater than the one at Pisa.



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Manual on Precast Concrete Construction. A complete report on precast concrete construction techniques including sections on patents, bond-breaking, construction schedules, field layout, forms, joinery, erection methods and a study of costs. The book contains numerous illustrations and many tables of practical information such as the table on "liquid bond-breakers" which lists the available solutions, their cost and field experience with them. The fee for the Manual is $25 plus sales taxes, or $12.50 in lots of ten or more. For further information on the sale of this publication write to the author, F. Thomas Collins, 921 West La Tunas Drive, San Gabriel, Calif.

Structural Analysis. Analysis procedure for continuous plane frameworks developed by R. W. Stewart, chief engineer of bridge design for Los Angeles, Calif., is described in *Die Traversen-Methode*, translated and revised to conform to German practice by Dr. Ing. A. Kleinlogel. The volume is based on Mr. Stewart's work, *The Traverse Method for Analyzing Continuous Structures*, published in 1948. Unknown in Europe until now, the traverse method is statically and mathematically exact in its use of the elastic theory. Publisher of the 108-page illustrated book, which sells for 17.50 D.M., is Wilhelm Ernst & Sohn, Berlin, Germany.

Plan for Washington, D.C. An example of effective cooperation among citizens and public officials in seeking a solution to the problems of urban expansion is made available in a report of the Citizen's Advisory Committee on Public Works for the District of Columbia. Entitled *Our Nation's Capital*, the report covers the two basic criteria guiding the committee—will the public benefit and can the benefits be provided on a sound financial basis? The schedule of needed construction recommended by the committee totals $319,152,000. Inquiries concerning the report should be addressed to the Board of Commissioners, District of Columbia Government, Washington, D.C.

Atomic Energy in Industry. Articles by thirty outstanding leaders in the atomic energy field have been made available in a transcript just released by the National Industrial Conference Board. Subjects include the place of nuclear power in the nation's electric power supply; current industrial uses of atomic by-products; applications to food and agriculture, pharmaceutical and medical uses; and problems of industrial participation in atomic power development. Transcripts of the symposium—the most comprehensive conducted to date on agricultural, medical, and industrial applications in the field—are available at $10 a copy from the National Industrial Conference Board, 247 Park Avenue, New York 17, N.Y.

Engineering Drawing. A comprehensive practical guide to engineering drawing is presented in one of the Barnes and Noble College Outline Series. The 432-page, paper-bound publication covers basic principles and rules, and includes problems, tables, ASA Standard Drawings, and drafting room practice. The authors are Josef V. Lombardo, of Queens College; Lewis O. Johnson, of New York University; and W. Irwin Short, of the University of Pittsburgh. The book sells for $2, and requests should be sent to Barnes & Noble, 105 Fifth Avenue, New York 3, N.Y.

Hydraulic Research. A demonstration and application of the concept of separable primary flow and superimposed secondary flow to incompressible flow in a guide vane bend are set forth in a recent publication of the St. Anthony Falls Hydraulic Laboratory, identified as Technical Paper No. 14, Series B. The paper, which is written by Edward Silberman and entitled *Importance of Secondary Flow in Guide Vane Bends*, is based on research sponsored by the Office of Naval Research and condensed from a technical report prepared for that organization. Inquiries should be addressed to the St. Anthony's Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, Minn.

Water Resources, Canada. Issuance of Volume 106 of the Canadian Water Resources Papers, *Surface Water Supply of Canada*, covering runoff data for the climatic years, 1946–1947 and 1947–1948, is announced by the Canadian Department of Resources and Development. Copies, priced at $3 each, may be obtained from the Chief, Water Resources Division, Department of Resources and

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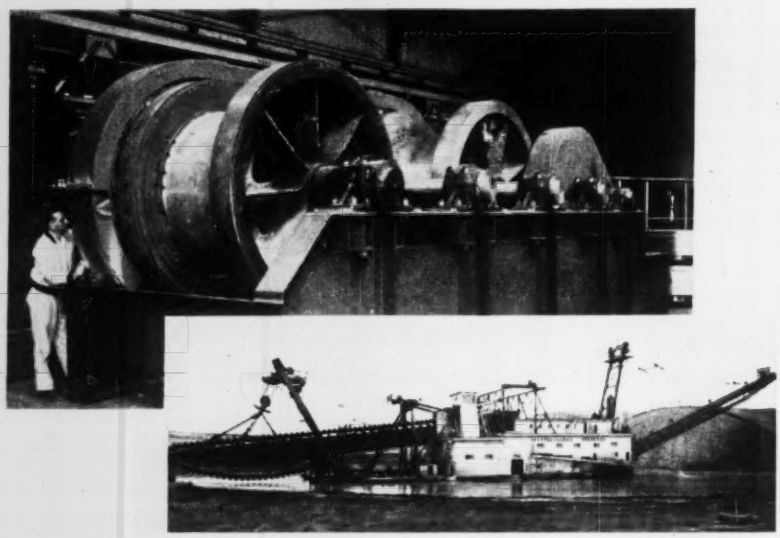

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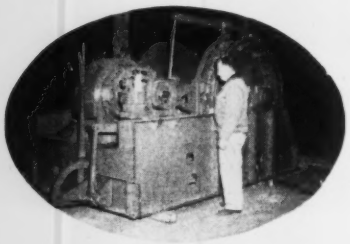

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Materials Testing. A much needed key to the tremendous volume of material on the properties and testing of materials, appearing in publications of the American Society for Testing Materials in the half century of its existence, is provided in a comprehensive index issued by the ASTM. The 230-page listing, the first overall index to be published by the society, covers all papers, reports and special publications for the 50-year period through 1950. Copies, priced at $6, are available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Pollution Control. More than 156 California communities constructed sewerage facilities costing in excess of $163,000,000 during the three-year period ending December 31, 1952. This is one of the significant facts brought out in a recent report prepared by the State and Regional Water Pollution Control Boards at the request of the legislature. Copies of the report, which is entitled *Water Pollution Control* and identified as WPCB Publication No. 5, may be obtained from any of the Regional Boards or from the office of the State Water Pollution Control Board, Sacramento, Calif.

Hydrology. Hydrologic studies of rainfall and runoff in the Champaign-Urbana, Ill., area, currently under way in the Department of Civil Engineering at the University of Illinois, are reported by Ven Te Chow in Hydraulic Engineering Series No. 2. Free copies of the report, entitled *Hydrologic Studies of Urban Watersheds*, are available from Prof. J. J. Doland, Department of Civil Engineering, University of Illinois, Urbana, Ill.

Building Code, Cleveland. Issuance of a building code—entitled *Regional Dwelling House Code* and devoted exclusively to single- and two-family dwellings—is announced by the Cleveland Regional Planning Commission. The culmination of three years of research and study, the code is primarily concerned with homes constructed in the conventional manner of wood interior framing and either woodframe or masonry exterior walls. However, it does not exclude the use of other materials and methods of construction, and prefabricated houses receive special consideration. Proctor Noyes served as director of the Commission, and Prof. Leslie J. Reardon, of Case Institute of Technology, directed preparation of the report. Copies may be purchased, at $5 each, from the Regional Planning Commission, 415 The Arcade, Cleveland 14, Ohio.

Mississippi River Maps. A folio of maps of the Mississippi River from Angola, La., to Head of Passes, La., and South and Southwest Passes and Pass à Loutre, La., showing river soundings and soundings in the Passes, is available for sale from the Office of the President, Mississippi River Commission, Vicksburg, Miss. Prepared by the New Orleans District of the Corps of Engineers, the 84-sheet folio is priced at $1.50.

Industrial Safety. A complete catalog of the many and varied accident-prevention aids available from the National Safety Council is now obtainable from the Council, 425 N. Michigan Avenue, Chicago 11, Ill. Copies are free, and the title is *Occupational Safety Services* (Service Guide 2.1).

Slide Rule Use. The infinite possibilities in slide rule use are set forth in a new booklet by H. W. Leach and George C. Beakley, of the engineering staff of Tarleton State College (Texas). Designed for college and high school courses, the text combines explanation and discussion of the various slide rule operations with drill problems. For instructors desiring additional drill material, a workbook of slide rule problems is available from the authors. The present publication, which is entitled *The Slide Rule*, may be obtained from the MacMillan Company, 60 Fifth Avenue, New York 11, N.Y. The price is $1.

Highway Planting. Results of a research project on vegetative cover for highway roadsides, conducted by the New York State Department of Public Works in 1951 and 1952, are summarized in a recent illustrated brochure called *Roadside Vegetative Cover Research Project*. The report emphasizes the economies that can be effected by proper establishment of turf during the construction of highways. The project was conducted in cooperation with Cornell and Rutgers universities. Inquiries should be sent to the Landscape Bureau, New York State Department of Public Works, Albany, N.Y.

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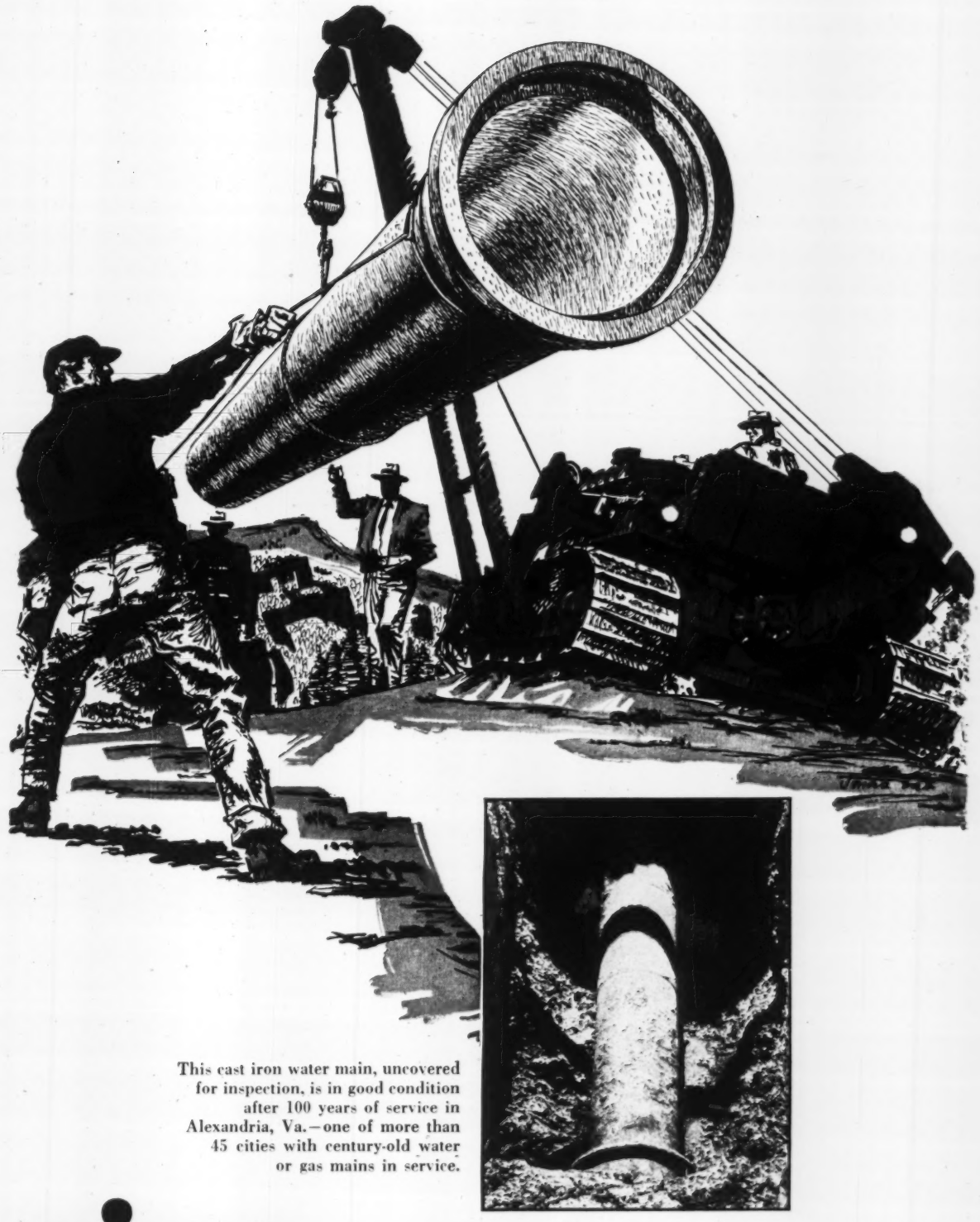

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This compilation prepared by ASTM Committee A-1 on Steel, contains in latest approved form the 56 ASTM specifications for carbon-steel and alloy-steel pipe and tubing, including stainless. The major categories into which the specifications are grouped are as follows: Pipe, boiler, superheater, and miscellaneous tubes; still tubes; heat-exchanger and condenser tubes; castings; forgings and welding fittings; bolting; grain size. Two special grain-size charts for classification of steels are included. Sixteen emergency, alternate provisions applying to specifications in this compilation are printed in a separate section at the back of the book. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, 1952. 383 pp., $3.75.)

Surveying. Theory and Practice

While intended primarily as a college textbook, this standard work, by Raymond E. Davis and Francis S. Foote, also aims to provide, in a single volume, a sufficiently comprehensive treatment to be of value to engineers and surveyors. For this purpose the more advanced phases of the subject are discussed, and methods used on extensive surveys are described and evaluated. The new edition has been rewritten where necessary and additions have been made to cover new equipment and methods. (McGraw-Hill Book Company, 330 West 42nd St., New York 36, N.Y., fourth edition, 1953. 1021 pp., $8.)

Theory of Homogeneous Turbulence

The author, G. K. Batchelor, presents a systematic account of the present state of knowledge in the field. After a brief review of the major contributions of the past fifteen years, the following topics are discussed: Mathematical representation of the field of turbulence; kinematics of homogeneous turbulence; linear problems; dynamics of decay; the universal equilibrium theory; decay of energy-containing eddies; and the probability distribution of u(x). A bibliography of research through 1952 is included. (Cambridge University Press, 32 East 57th St., New York 22, N.Y., 1953. 197 pp., $5.)

Proceedings of the First U.S. National Congress of Applied Mechanics

Reporting the first of a series of congresses to be held at approximately four-year intervals, this volume contains 125 papers on a wide range of topics arranged in four major groupings: General methods, dynamics, vibrations, impact; elasticity, photoelasticity, plate theory, elastic instability; plasticity, behavior of materials, failure; fluid flow, aerodynamics, heat. Five general lectures are also included dealing respectively with elastic stability, creep in metals and polymers, fluid flow theory, high-speed aerodynamics, and the relationship of heat transfer to mechanics and other branches of science. As these congresses are intended primarily for those interested in applied mechanics in this country, no attempt was made to attract participation from abroad. (American Society of Mechanical Engineers, 29 West 39th St., New York 18, N.Y., 1952. 965 pp., $20.)

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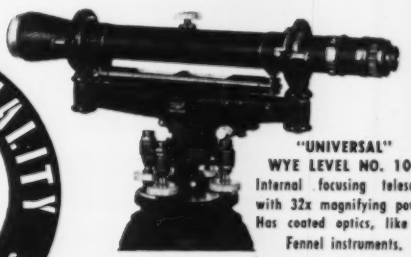

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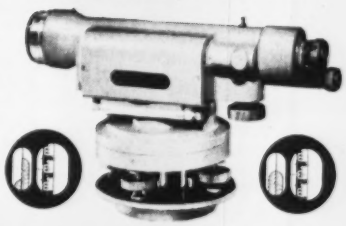

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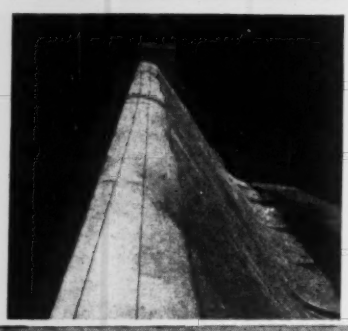

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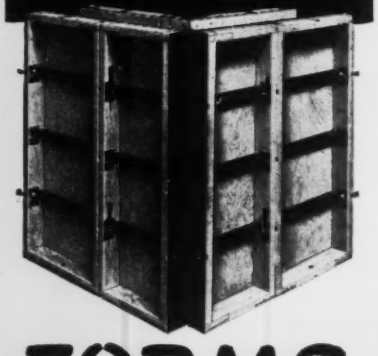

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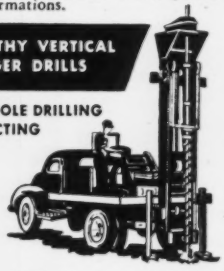

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discussion of the relation of geology to topography; Part III, ground, aerial, and stereo-photogrammetry; Part IV, hydrographic surveying and stream gaging; and Part V, constructing and finishing maps. Effectively illustrated, the volume also contains some 30 pages of tabular data in addition to that included with the text. Methods for the adjustment of triangulations and level circuits are appended. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., seventh edition, 1953. 675 pp., $7.)

Simplified Design of Roof Trusses for Architects and Builders

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General Discussion on Heat Transfer, Proceedings

The objective of this symposium held by the Institution of Mechanical Engineers, in September 1951, is to review developments in the knowledge of the principles of the transference of heat and in the design of apparatus-making use of such knowledge, within the period 1940–1950. Ninety-three papers are presented divided under five main headings: Heat transfer with change of state; heat transfer between fluids and surfaces; conduction in solids and fluids; radiation, instrumentation, measurement techniques, and analogies; special problems such as heat transfer in turbine blade cooling in liquid metals, in gas turbines, etc. Authors include specialists from several other countries as well as from the United States and Great Britain. (Available in the United States from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., 496 pp., $10.)

A Policy for Scientific and Professional Manpower

This report, by the research staff of the National Research Council, consists of two parts: A statement of policy for scientific and professional manpower, and a study of the facts upon which the policy recommendations are based. The first part gives the Council's recommendations to government, industry and educational institutions, designed to provide the nation with adequately trained scientific and professional workers. The second part depicts and analyzes existing shortages, discusses the actual and potential educational attainments of the population, and considers factors impeding the training of capable persons. Separate chapters give detailed appraisals of the shortage of engineers, physicists, teachers, and medical personnel. The concluding chapter deals with present public policies and attitudes towards scientists and professional men. (Columbia University Press, 2960 Broadway, New York, N.Y., 1953. 263 pp., $4.50.)

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JUNIOR ENGINEER; J. M. ASCE; 23; married; 1951 C. E. graduate; speaks Spanish fluently, familiar with German; considerable summer experience in field and office. Would like to learn construction. Now in the Marine Corps; will be available October 15, 1953. Location preferred, South, West or foreign. C-867-536-A-14-San Francisco.

CIVIL ENGINEER; J. M. ASCE; 25; single; B.S. in C.E., 1950; 1 year's experience in structural steel detailing on bridges and buildings; 15 months' experience field engineering; 2 years' experience with Corps of Engineers. Desires position with engineering firm. Location, East or Midwest preferred. C-868.

CIVIL ENGINEER; J. M. ASCE; 29; married; B.S. and M.S. in C.E.; registered civil engineer in Ohio; 9 months' experience in hydraulic laboratory; 4 years' experience in surveying, hydraulic and sanitary engineering. Interested in fall appointment with college or university or position with engineering firm. Location preferred, West. C-869-536-A-11-San Francisco.

CIVIL ENGINEER; J. M. ASCE; 29; married; B.S. in C.E.; registered professional engineer in Oklahoma; 5 years' experience with leading consulting firm doing water supply, distribution and municipal work; experienced in office, design, and in engineering supervision of construction. Location preferred, southwestern, western, or southern United States. C-870-663-Chicago.

CIVIL ENGINEER; A. M. ASCE; 37; married; B.S. in C.E., 1949; 14 years' varied experience including highway design, reinforced concrete and railroad design and waterworks engineering. Desires permanent position combining field and office work with consultant, contractor or municipality. Any location in United States. Good working knowledge of Spanish. C-871.

IRRIGATION ENGINEER; A. M. ASCE; 44; registered; 3 years' with railway; 7 years' irrigation, western U.S.A.; 10 years' adviser to foreign governments on irrigation, conservation, mechanization. Fair command of Spanish. Desires position with headquarters in United States. Will travel domestic or foreign. C-872.

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CIVIL ENGINEER; J. M. ASCE; 26; married; B.S. in C.E., Louisiana State University, 1950; 3 years' experience in sanitary and municipal engineering. Desires position with engineering firm in Louisiana or Mississippi. C-874-664-Chicago.

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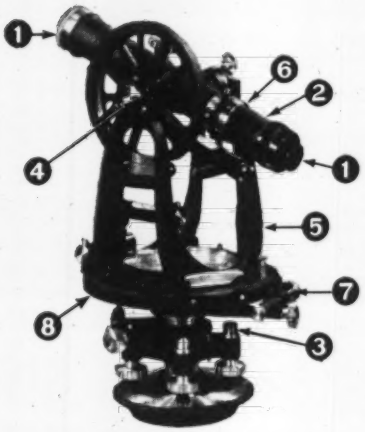

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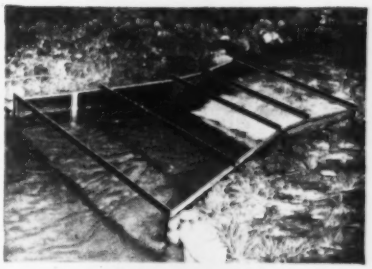

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Non-ASCE Meetings

Alaskan Science Conference. The Southeastern branch of the Alaska Division of the American Association for the Advancement of Science will act as host to the fourth Alaskan Science Conference at Juneau, September 28–October 2. Special conference rates are being offered by the Gastineau and Baranof hotels.

American Institute of Chemical Engineers. The American Institute of Chemical Engineers will meet at the Fairmont and Mark Hopkins hotels in San Francisco, Calif., September 13–16.

American Institute of Electrical Engineers. Headquarters for the Pacific general meeting of the American Institute of Electrical Engineers will be the Vancouver Hotel, Vancouver, B.C., September 1–4.

American Road Builders' Association. The county and local roads division of the ARBA is sponsoring a national highway conference of county officials at the Dell View Hotel on Lake Delton, Wisconsin, September 24–25.

Chi Epsilon. A meeting of the New York Alumni Chapter will be held in the Engineering Societies Building, Room 1101, W. 39th Street, New York City, on September 2, at 7:30 p.m. It will be preceded by an informal dinner in the New York Times Dining Room, 11th floor, 229 W. 43rd Street, at 6 p.m.

Engineering, Marine & Welding Exhibition and Chemical Plant Exhibition. The nineteenth Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition will be held at Olympia, England, September 3–17.

Fourth Symposium on Plasticity. The Fourth Symposium on Plasticity will be held on the campus of Brown University, September 1–3. Papers of particular interest to civil engineers will be presented in one session—sponsored jointly by the Engineering Mechanics Division of ASCE and the University—on Tuesday afternoon, September 1. Further information may be obtained from Prof. H. J. Weiss, Graduate Division of Applied Mathematics, Brown University, Providence 12, R.I.

International Navigation Congress. The 18th Congress of the Permanent International Association of Navigation Congresses will meet in Rome, Italy, September 15–22. Information may be obtained from the Secretary, American Section, PIANC, c/o Board of Engineers for Rivers and Harbors, 119 D Street, N. E., Washington 25, D.C.

Joint ASEE-ECPD Meeting. A joint meeting of the American Society for Engineering Education and the Engineering Council for Professional Development is scheduled to be held at the Hotel Statler, New York, N.Y., October 14–17.

Society of Automotive Engineers. The international West Coast meeting of the Society of Automotive Engineers will take place at the Hotel Georgia, Vancouver, B.C., August 17–19.

Summer Program in City and Regional Planning. The fifteenth in the annual series of special summer programs in city and regional planning will be held at the Massachusetts Institute of Technology,

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August 21–September 4. Further information and application blanks may be obtained from the Director of the Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Third International Congress on Soil Mechanics and Foundation Engineering. The first part of the Third International Congress on Soil Mechanics and Foundation Engineering will be held at Zurich, Switzerland, August 16–21. Following a four-day trip through Switzerland (August 22–25) the Congress will hold its final session at Lausanne on August 26. All correspondence relative to the Conference should be addressed to Dr. I. von Moos, General Secretary, Gloriastr. 39, Zurich 6, Switzerland.

Applications for Admission to ASCE June 13–July 4

Applying for Member

ANTON ADOLPH ANJEL, Ankara, Turkey.
CHARLES EMMETT BROKAW, Cincinnati, Ohio.
CLIFTON HARLAND CHADWICK, New York, N. Y.
WEN-TAO CHANG, Washington, D.C.
CHARLES EMMETT DAHLGREN, St. Peter, Minn.
SIDNEY FADEN, Los Angeles, Calif.
HAROLD K. FRIEDLAND, Los Angeles, Calif.
HAROLD PRICE KING, Sherman Oaks, Calif.
HARRY SELIG LEWIS, Paris, France.
SIDNEY LICKTON, Clearwater, Fla.
ALBERT EDWARD MEDLAND, Rochester, N.Y.
JOHN FULTON MOLLER, Bozeman, Mont.
GEORGE EDWARD PAUL, Philadelphia, Pa.
EDWARD FRANKLIN REAM, JR., Chicago, Ill.
LELAND SYLVAN ROSENER, JR., San Francisco, Calif.
HENRY A. SIKSO, Omaha, Nebr.
JAMES LACHLAN TAYLOR, Chicago, Ill.
CYRIL FRANK VIRR, Topeka, Kans.
VIRGIL ALFRED WALSTON, Houston, Tex.
ROSCOE ALAN WEAVER, Berkeley, Calif.
ROBERT STEVENS WOODRUFF, Fort Worth, Tex.

Applying for Associate Member

IRVIN POSTON BADGER, Athens, Ohio.
S. PAUL BARNES, Oklahoma City, Okla.
KONNANATT BHARATHAN, Madras, India.
DAVID DARIO BRILLEMBOURG BRAVE, Caracas, Venezuela.
DANIEL HUNTINGTON CHAPPELL, Kansas City, Mo.
WILLIAM CLARK CRAIG, Austin, Tex.
VAUGHN ELMO EPPERSON, Salt Lake City, Utah.
WILLIAM ROBERT FAUST, San Antonio, Tex.
CHARLES KESTER FREEARK, Los Angeles, Calif.
HERBERT LEWIS GRAY, Boulder, Colo.
CURTIS HOOPES HANNUM, Charlottesville, Va.
ALLEN KEENE HENRY, St. Petersburg, Fla.
ELMER YORK HOLLIS, JR., Paducah, Ky.
ALLEN HARRY JONES, Denver, Colo.
CARL WESLEY LEWIN, Palatine, Ill.
HARRY KAZUMI MAKINO, Honolulu, T.H.
JOHN HENRY McVEY, Los Angeles, Calif.
CHRISTOS COSTAS MICHAELIDES, New York, N.Y.
ROBERT LYLE MORRIS, San Francisco, Calif.
HAROLD MORGAN NOBLE, Newport Beach, Calif.
WILLIAM BILLINGS PETWAY, Fallbrook, Calif.
WILLIAM RALPH REESE, Troy, N.Y.
PAUL RHOADS, Denver, Colo.
JOSEPH ANDREW ROWE, San Bernardino, Calif.
LEO SCHENKER, Ann Arbor, Mich.
OLIN L. SHAFFER, Fairbanks, Alaska.
CECIL PAUL SQUIRES, North Augusta, Ga.
NAZAR VIELI, San Francisco, Calif.
JACOB WELK, New York, N.Y.

Applying for Affiliate Member

GEORGE ALEXANDER BRENNAN, SR., Chaman, Pakistan.

Applying for Junior Member

AUBREY RUSSELL AVERY, Klamath Falls, Oreg.
DONALD LYNNE CHAPMAN, St. Paul, Minn.
JOHN PAUL FAJNOR, San Francisco, Calif.
JOHN BAPTIST FREUND, Moline, Ill.
CLAYTON LEROY KITTINGER, Cleveland, Ohio.
ROBERT WILLIAM LONG, Baltimore, Md.
CHARLES JULIAN LORD, Los Angeles, Calif.
JOHN FRANKLIN MAXWELL, Paducah, Ky.
JAMES JOSEPH O'BRIEN, Sacramento, Calif.
MOSHE PORAT, New York, N.Y.
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[Applications for Junior membership from ASCE Student Chapters are not listed.]

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EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Trench Hoe Boom

AN OPTIONAL HEAVY duty trench hoe boom for the Gar Wood 75 Series excavators has been announced. Designed for extra rugged excavation, cross country pipe line work and other extreme operations, the boom weighs 8500 lbs. As is the standard trench hoe boom, it is easily removed for conversion to shovel, crane,

Designed for Rugged Excavation

drag line, clam shell, pile driver and the exclusive foundation borer attachments on the 75A, the heavy duty 75B and the 75BT truck crane. **Gar Wood Industries, CE 8-110, Customer Service Dept., Wayne, Mich.**

Dump Body

PRODUCTION of a "rock" type dump body for extra heavy duty hauling of abrasive materials is announced. Designed especially to withstand the hard shock of power shovel, chute and conveyor loading, the unit is available in from 5 to 15 yd sizes. Body is constructed throughout of high tensile steel plate and features extra wide box type side bracing, both horizontal and vertical, on the head sheet and sides. The "rock" body design completely eliminates side bulging which is the most common cause of heavy duty body failures. Driver's compartment is amply protected by a sturdy, box braced, full size cab protector. "Rock" body sides fold into body floor at a 45 deg angle to prevent material from lodging in corners. This angle is reinforced with flat 45 deg steel plates at load-spaced outrigger type crossmembers. Body floor is also reinforced with a 2-in. hard wood liner inside the floor shell and wear plate. Need for a tailgate is eliminated by employment of a 15 deg angle scow type rear end, supported by angular box braces which are an extension of the understructure longitudinals. This scientifically sloped rear packs the load firmly in place and does away with the need for operating a tailgate on extra large loads. Another outstanding "rock" body feature is its "Distorber" mounted on each side of the truck body and hoist frame. **The Galion Allsteel Body Company, CE 8-110, Galion, Ohio.**

Calculator

THE MODEL II Curta Calculator will now handle problems of 11 by 8 by 15 digits. Its increased capacity has been achieved through little sacrifice in weight and portability. The Model II still fits easily in the hand and weighs but 12 oz. This all-metal fully guaranteed bantam calculator is a valuable tool for all types of engineering, office and field calculations. **Curta Calculator Co., CE 8-110, 3851 W. Madison St., Chicago 24, Ill.**

Forkloader

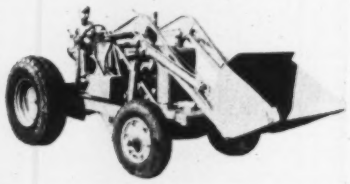
A 4-WHEEL-DRIVE Forkloader with 5 speeds forward and reverse, designed for heavy-duty operation on rough terrain, mud, snow and sand has been announced. Designated the 60N Series, the Forkloader has a lifting capacity of 6000 lbs. Use of positive 4-wheel-drive and large, low-pressure high-flotation tires makes the unit highly effective on nearly any operating surface. A 23 in. oscillation of the rear axle about the longitudinal axis permits 4-point traction on extremely rough

60N Series

terrain—squashing action of the hi-flotation tires on soft ground prevents excessive sinking action. Stability of the Forkloader is inherent in special design which places the engine over the rear wheels, plus use of ballast counterweights at the rear of the unit. A 100 in. wheelbase provides anti-roll stability. With a full load (6000 lbs) on the forks, there is ample weight on the rear wheels to maintain traction at all times. Maneuverability of the unit is increased through use of a shuttle-gear transfer mechanism in transfer case, providing 5 forward and 5 reverse speeds. High operating speeds and rubber tires make the Forkloader self-transporting on large area projects eliminating need for truck and trailer hauling. **Dept. KP, Baker-Raulang Co., 1250 W. 80th St., Cleveland 2, Ohio**

Shoveloader

THE COMBINATION of cheap diesel power with front-end loading up to 5000 lbs capacity is featured in the Baker-Lull Shoveloader, mounted on a Sheppard industrial wheel-type tractor. Diesel power will return fuel cost savings up to 75 percent, compared with the operation of gasoline powered equipment. Other advantages include extremely low replacement costs,



Mounted on a Sheppard Tractor

an 8-speed transmission that permits full throttle operation at each job speed, and the design of Sheppard tractors for use in critical conditions of mud, water and uneven ground. The Shoveloader has 66 percent more lifting power than comparable units. It will crowd and dig below tractor level, lift a 5000 lb capacity load to 10 ft 3 in., dump it at 8 ft 6 in., and reach 5 ft 10 in. ahead of the tractor radiator shield. Lift speed is 12 sec., lowering speed, 9 sec. Special double-acting hydraulic cylinder design enables the operator to shake the materials bucket thoroughly clean, adding to operating efficiency. The unit is engineered for clear visibility ahead in critical loading or unloading positions, and all actuating parts are located well ahead of the operator for safety. Tools available with the Shoveloader include a material bucket, combination coal and snow bucket, bulldozer, lifting crane, sweeper (for snow clearance and clean-up), rear leveling blade scarifier and logging fork. **Dept. KP, Baker-Lull Corp., 314 W. 90th St., Minneapolis 20, Minn.**

Hoist Protector

EXTRA PROTECTION for Towmoter lift trucks operated in dusty or abrasive conditions is assured by a hoist protector. Specially recommended for installation on all fork lift trucks used in scoop operations, this tubular steel protector telescopes upward or downward to match the movement of the lift plunger. Thus, the plunger is constantly shielded from excessive pitting and scoring by any abrasive agents that may be encountered. Available as original equipment at extra cost on most Towmotor models, the hoist protector can also be adapted to six types of Towmotor lift trucks. **Towmotor Corporation, CE 8-110, Cleveland, Ohio**

Equipment, Materials & Methods (Continued)

Hydro-Mixer

A 4-1/2 to 5-1/2 cu yd hydro-mixer has been announced. A new feature is the drum drive by reversible hydraulic motor, operated by power take-off from truck transmission. This saves weight by eliminating heavy auxiliary gasoline engine. It permits installation on shorter wheelbase trucks for increased maneuverability. The Hydro-Mixer is suitable for mounting on most ten-wheel trucks having 147-in. average wheelbase. The drum drive by power take-off to reversible hydraulic motor turns the drum by chain and sprocket at 8 to 12 rpm for charging or discharging and 3 to 5 rpm for mixing in transit. Control is by valve which changes direction of fluid in hydraulic motor. A check valve prevents drum roll back while shifting gears. The power take-off is controlled from the cab. Mixing and discharge are controlled from the left front or the left rear by throttle and hydraulic valve. Construction of the mixer's frame is unusually strong and the drum itself is stiffened by two continuously welded overlapping mixing spirals. Both charging and discharging hoppers are designed with large collecting areas. **Willard Concrete Machinery Sales Co., CE 8-111, 11700 Wright Road, Lynwood, Calif.**

Line Marker Machine

TRAFFIC AND SAFETY lines that are printed—rather than brushed or sprayed—are now possible as the result of an improved all-metal sled-type, roller spreader perfected for the Controlled-Flo Traffic-Line Paint-Striper. The printed line is sharper, cleaner and lasts longer while the machine's marked mobility, silence and ease of operation make it ideally suited to line street crossings, safety zones, parking areas, roads, highways and construction projects. Maintenance requirement for the spreader—which outlasts hundreds of brushes—is only a can of kerosene or ordinary paint thinner for immersion when not in use. The machine's simple maintenance stems from the fact that it is gravity fed and has no power unit. Consequently, it has no hose to blow out, no jets to clean, no pressure tank to worry about, no brush or felt bands to maintain or replace and no gas engine or compressor to complicate operation or maintenance. The machines are used with excellent results on any surface such as black top, macadam, concrete, asphalt or wood. **Line Marker Division, Universal Yonkers Corp., 137 Alexander St., Yonkers 2, N. Y.**

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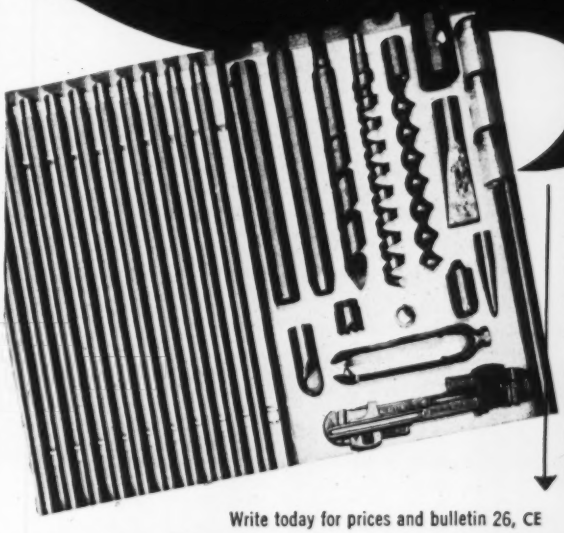

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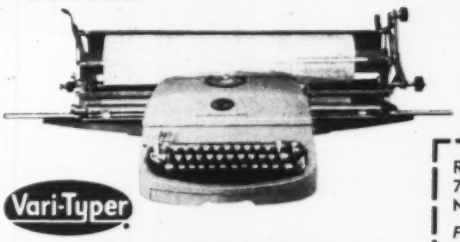

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Equipment, Materials & Methods (Continued)

Portable Dryer

A PORTABLE ASPHALT dryer is now in production. Developed especially for use with the Moto-Patcher, the dryer has a drying capacity of up to 10 tons per hour. Aggregate feeding is by rotary elevator from truck, or hand feed. Drum is 8 ft long and 30 in. in diameter. The fuel oil tank has a capacity of 40 gal, and the oil burners are low pressure air-atomizing. The power unit is a Briggs & Stratton Model 23 R6 with reduction gear, and Viking fuel pump. Ball bearings and roller chain are used throughout. The unit is readily attachable to any standard make truck with towing hitch. The landing gear is of the retractable swivel type with 3:50 × 6 — 4 ply tire and adjustable leveling device. Running gear is two wheel single axle with leaf springs. **Hetherington & Berner, Inc., CE 8-112, 700 Kentucky Ave., Indianapolis, Ind.**

Front-End Loader

THE INTRODUCTION of the 6K3 Skid-Shovel, designed and built exclusively for mounting on the TD-6 International tractor is announced. The Drott 6K3 front-end loader has all the "bonus features" of the larger models including; clean design, job versatility, break-out action, Hydro Spring for reducing shocks, shoe transportation and reverse cylinder action. The Drott 6K3 has a $^{7}/_{8}$ yd capacity with a digging or breaking out force of 8500 lbs. It has a lifting capacity of 3000 lbs. This new model has met with "field proven" popularity wherever bulk handling of material is vital. With the introduction of this new model there are now available four models of Drott front-end leaders for installation on the TD-6, TD-9, TD-14A and TD-18A International tractor. There is a shovel to fit any condition—any operation, large or small. **The Drott Manufacturing Corporation, CE 8-112, Milwaukee 8, Wis.**

Joining Reinforcing Bars

DEVELOPMENT OF A new method for the joining of reinforcing bars into long, continuous lengths has been completed recently. Essentially a simplification of the fifty-year-old Thermit welding process, the method is speedier and more economical than electric arc welding or other methods. It has been field tested by Corbetta Construction Company in construction of the piers on the Tappan Zee Bridge of the New York State Thruway where approximately a thousand welds meeting the requirements of New York State Engineers were made. Briefly, the procedure consists of trimming the reinforcing bar ends with a gas cutting torch, spacing them $^{1}/_{2}$ to $^{5}/_{8}$ in. apart, clamping a preformed mold around the joint, filling the mold with Thermit and igniting. Thirty seconds later the weld is completed. **Metal and Thermit Corp., CE 8-112, 100 East 42nd St., New York 17, N. Y.**

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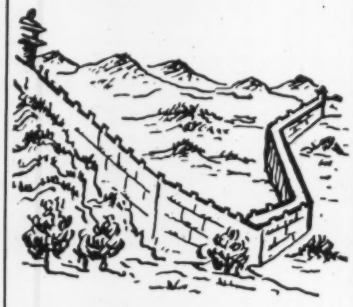

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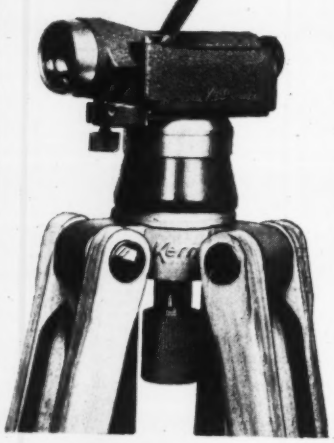

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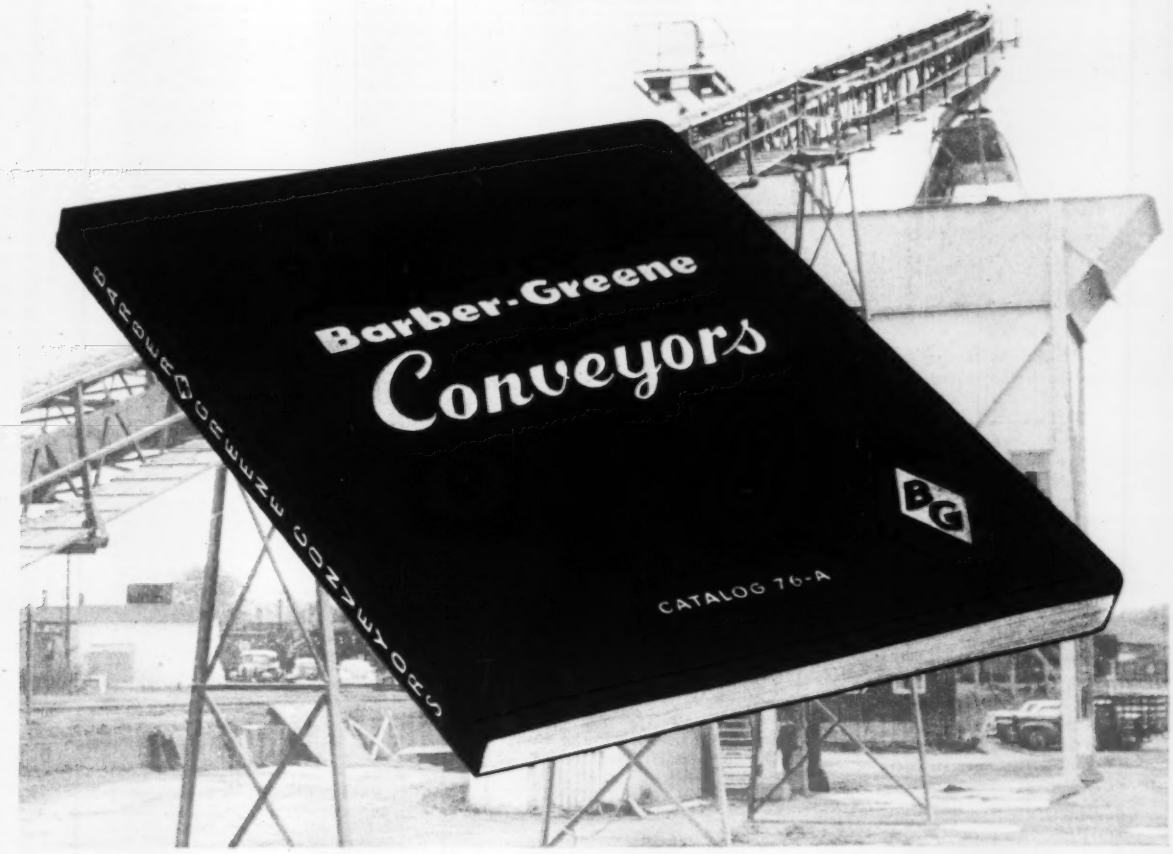

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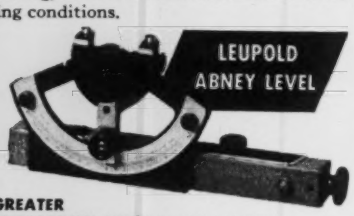

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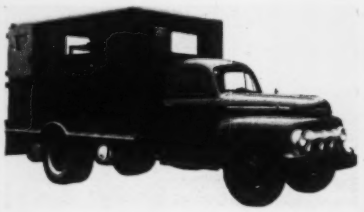
Equipment, Materials & Methods (Continued)

Compass

THE MANUFACTURE of a compass, known as the Vemco Speed-Bow has been announced. Designed for the modern, all-pencil drafting technique, the compass features speed, capacity, precision, versatility, and durability. The Speed-Bow draws circles from $\frac{1}{8}$ in. to 10 in. in diameter, the coarse settings being made quickly by a finger-pressure release and the fine adjustments by a thumb screw. Carbon steel and stainless steel are employed to make this compass extremely durable. The simple, sturdy design and construction assure rapid, precision adjustments. The versatile instrument is equipped for use with pencil and four types of pen attachments; with the addition of two needle points it becomes an accurate, efficient divider, capable of scribing on steel. **V. & E. Manufacturing Co., P. O. Box 950 M, Pasadena 20, Calif.**

Mobile Soils Laboratory

A TRUCK-MOUNTED mobile soils testing laboratory has been announced. The mobile laboratory is designed for use in field testing of soils in the design and control of construction for dams, levees, roads, airfields, pipelines and similar



Designed for Field Testing

structures. The laboratory is a self contained unit, outfitted in a custom built steel van type body. Electrical power is supplied through an automatic starting electric plant; distilled water and wash water tanks are built into the laboratory body; and an air compressor and receiver are also mounted on the unit. Benches, storage cabinets and working spaces are arranged to allow three technicians to work in the laboratory. It is equipped to perform standard soil tests for: grain-size, liquid limit, plastic limit, shrinkage limit, specific gravity, compaction, field density, California Bearing Ratio, unconfined compression, load bearing and permeability. Special units can be equipped for consolidation and triaxial testing of soils or for tests of asphalt, bituminous materials and concrete. The use of the mobile laboratory eliminates the necessity of constructing a special building and facilities in the field for relatively short operations. The laboratory is supplied complete and ready for operation. **Soiltest, Inc., CE 8-114, 4520 W. North Ave., Chicago 39, Ill.**

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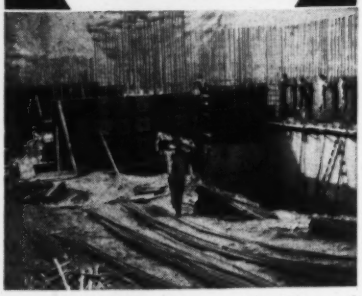

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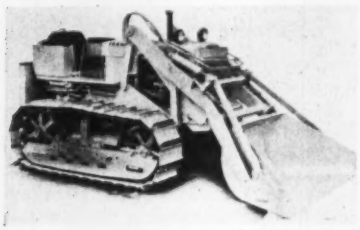
Equipment, Materials & Methods (Continued)

Digging Loader

A VERSATILE DIGGING loader known as the Terraload'r has been announced. The machine has many features not usually found in industrial equipment in the lower price range. It is particularly popular with builders and contractors. The Terraload'r can be used to load trucks and railroad gondolas. It digs trenches and grades as a bulldozer, and can carry loads



Terraload'r

from the site of one activity to another. A powerful hydraulic lift and control valve permits a float position for the efficient handling of loose materials when dozing or loading. The close forward mounting allows unrestricted access to tractor seat and controls. Excellent operator visibility has been combined with full excavating width, ample dumping height and reach. Of special interest is the ability of the Terraload'r to doze efficiently without "roll-under." With the bucket pivoted at the front rear cutting edge, power is transmitted with minimum effort. For backfilling operations, down pressure insures finger-tip control for fast, efficient work. The machine is available in three models: GT-30, GT-34, and DT-34. The first model has a drawbar horsepower of 26.3, and is equipped with a $\frac{1}{2}$ yd bucket. The GT-34 has a drawbar horsepower of 30, and the DT-34 (diesel), 29. The latter two models are equipped with a $\frac{5}{8}$ yd bucket. All models have steel track shoes as standard equipment, with rubber track shoes or flat steel street plates as optional equipment. **American Tractor Corporation, CE 8-115, Churubusco, Indiana.**

Loader

THE MODEL 3 Force-Feed Loader, the original conveyor type windrow loader, is now available with attachments that give it new versatility for stockpile loading, snow removal and for work with the Athey portable breaker. Among the attachments are an auger-feeder front end for stockpile loading, fully winterized cab for year around work, side discharge conveyor for faster loading of trucks, three rear axle arrangements to meet any type power or flotation requirements, a cleated belt for loading snow, and the availability of 3 ft conveyor extensions for over-cab

(*Continued on page 116*)

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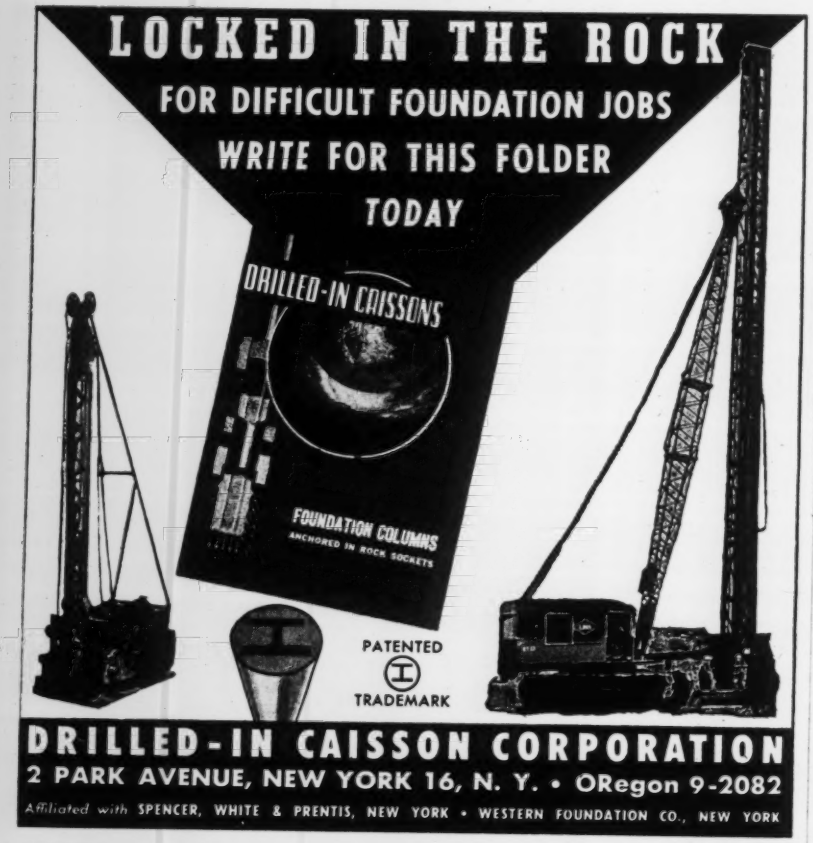
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Equipment, Materials & Methods (Continued)

loading. Though now available with a wide range of attachments, the Athey Model 3 Force-Feed Loader still includes the patented full-floating feeder which has made it the leader of loaders. Also, still included are the full-hydraulic controls, dependable Ford 100 hp industrial engine and direct mechanical drive that assures maximum capacity day-after-day with a minimum of down time. **Athey Products Corporation, Dept. CE-4, 5631 West 65th St., Chicago 38, Ill.**

Portable Asphalt Plant

TO MEET THE NEED of the construction industry for a completely portable, integrally-powered batch type asphalt plant, Standard Steel Corporation of Los Angeles has developed and is placing such a unit on the market. Many of the company's major stationary plant features have been incorporated in this portable outfit. The asphalt plant is 1000 lb capacity and is mounted on its own rubber-tired wheels. Complete with its own gasoline or diesel engine for operational power, it represents the last word in compactness. All that is required to place the portable unit plant in operation is to raise the mixing unit by means of an elevator device. Within a few hours from the time this portable unit is spotted into position, it is ready for operation. In transit the plant complies with highway clearances involving both height and weight and may be towed with a truck-tractor. **Standard Steel Corporation, CE 8-116, 5025 Boyle Ave., Los Angeles, Calif.**

Concrete Cutter

A PROBLEM RECENTLY encountered consisted of the demolition of a 240 ft long reinforced concrete wall and reconstruction of a second wall of similar length at a different location. By applying a Felker Di-Met Model 252 heavy duty concrete cutter to sectionalizing the existing wall, a contractor saved the entire structure and moved it in sections to the new location. To successfully complete the operation the concrete cutter was backed onto a fork lift truck which provided the vertical feed. The 18 in. Felker Di-Met segmented type diamond blade first sawed through the concrete at its base. The lift was then energized, feeding the blade upwards at a slow speed. Height of the 6 in. thick wall was 36 in. Each cut was completed in 12 min, a total of 9 cuts being made. Total cutting time, including all setups and preparational effort, was 8 hours. Wear on the Di-Met segmeted type diamond wheel was negligible. **Felker Manufacturing Company, CE 8-116, 1125 Border St., Torrance, Calif.**

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Fig. B-68. Type M (Circular) Gate

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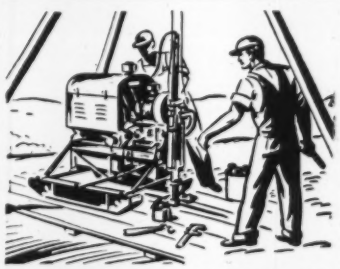

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Literature Available

WIRE ROPE FITTINGS—A 6-page brochure for users of wire rope fittings is available. It contains blueprint drawings, tables and ordering information on open and double wedge sockets, pins and continuous cable clamps. The brochure also shows pictures of the fittings in various field work and tells of other applications. **Sauerman Bros., Inc., Dept. C-18, 522 S. Clinton St., Chicago 7, Ill.**

VIBRATION ISOLATION EQUIPMENT—Vibration and noise isolation bases for fans and motors are described in detail in Catalog FB-802 recently published. Designed to give the maximum help possible to architects, engineers, etc., the catalog gives illustrations, descriptions and specifications for the twin rail base, vibro-var base, steel spring vibro-isolator, and other vibration isolation equipment manufactured by the company. **The Korfund Co., Inc., CE 8-117, 48-08-A Thirty-Second Place, Long Island City 1, N.Y.**

SOLVING ROOF PROBLEMS—Those concerned with roof maintenance will find "Solving Roof Problems," an attractive 32-page brochure, to be an absorbing and authoritative discussion of the matter. It is illustrated by photographs, drawings and diagrams, and thoroughly explores such subjects as the various types of roofs, how they are built, what factors enter into their deterioration, how roof troubles can be diagnosed and treated. **The Tremco Manufacturing Company, CE 8-117, 8701 Kinsman Rd., Cleveland, Ohio**

CONVEYOR & ELEVATOR BELTING—A 32-page manual on the installation and maintenance of conveyor and elevator belting has just been published. More than 60 photographs and drawings illustrate ways to improve belt service and to lengthen belt life. A chapter on how to select belts includes a discussion of belt design covers, reinforcements and grades. **B. F. Goodrich, CE 8-117, Akron, Ohio**

PRESTRESSED CONCRETE—"Aeroflex Plastic Tubing For Prestressed Concrete" is a new illustrated folder giving specifications and information about bond preventing split tubing used over wire rope or rods in post tensioned beams. The folder shows how this labor saving tubing is applied and contains a list of some of the sizes. **Anchor Plastics Company, Inc., CE 8-117, 36-36 36th St., Long Island City 6, N. Y.**

AIR HOSE—A number of different uses for the line of air hose produced by the company, is described in a bulletin. The uses vary from heavy-duty construction through digging and drilling operations, to many heavy and light industrial and commercial uses for air hose. The bulletin includes cross section and cutaway photos, as well as performance data, constructions, sizes, weights, working pressures and recommended uses. Also covered are the types of couplings best suited for the specific hose. **Quaker Rubber Corp., Div. of H. K. Porter Co., Inc., CE 8-117, Tacony and Comly Sts., Philadelphia 24, Pa.**

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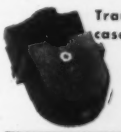

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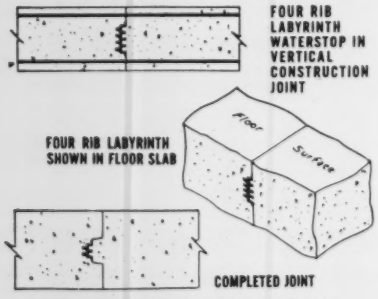

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Literature Available (Continued)

ROAD MACHINERY—A picture folder describing the Bros line of road machinery has just been released. The folder illustrates and describes Bros pneumatic tire rollers and giant 50-ton "Roll-O-Pactors," drum-type tampers. Bituminizer distributors, Spraymatic spray bars, portable steam generators and asphalt circulators are also shown. Ask for folder No. RE-113. **Road Machinery Div., CE 8-118, Wm. Bros Boiler & Mfg. Co., Minneapolis 14, Minn.**

CRANE—An 8-page catalog illustrating in color the heavy-duty, self-propelled, wheel-mounted Wayne Crane Model 20 has been published. Entitled "Meet the Heavyweights," the descriptive catalog is the first in a series of new literature which will combine many on-the-job applications with numerous money-making features that have been proved by Wayne Crane owners. These include simplified deck machinery layout, unique self-leveling chassis, oversize drums, and clutches and overall rugged construction. Complete specifications, operating data and lifting capacities are included in the catalog. **Wayne Crane Div., American Steel Dredge Company, Inc., CE 8-118, Fort Wayne, Ind.**

FLOW METERING—A technical information sheet for engineers and superintendents of water and sewage installations is now being offered. The publication, containing six pages of practical information on flow metering, is well illustrated with tables and curves, providing a simple method of calculating such factors as flow meter differential, orifice size, Venturi throat size, power consumption, capital investment and recovery period. **The Foxboro Company, CE 8-118, Foxboro, Mass.**

GRAVITY FILTERS—A comprehensive and well illustrated 24-page booklet (No. 2539A) which should be of interest to all operating, consulting and architectural engineers dealing with water problems, has been prepared. It shows the complete line of gravity filters, which are made in three basic types of concrete, of steel and of wood. Specifications, operating characteristics, outline dimensions and typical installations of these filters and associated accessories have been included in this edition. **The Permutit Company, CE 8-118, 330 West 42nd St., New York 36, N. Y.**

TRUCK MIXER—A bulletin, covering Blue Brute truck mixers and a specification sheet for the Blue Brute 3-1/2 S end discharge tilting mixer are being offered. The bulletin, No. R1700-B13, thoroughly describes and illustrates both the LC and LO Models of inclined-axis truck mounted concrete mixers. Many of the improved design features are illustrated by photographs or cut-away drawings indicating details of each. **Worthington Corp., CE 8-118, Construction Equipment Div., Plainfield, N. J.**

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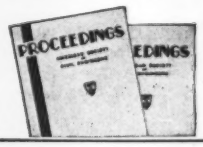

PROCEEDINGS AVAILABLE

The following papers have become available as Proceedings Separates. Following the date of issue of a paper, discussions thereof will be received for a period specified in the paper. Titles will be added every month, as they become available. Use the convenient order form on page 120.

176. **Advances in Sewage Treatment and Present Status of the Art: Progress Report of the Committee of the Sanitary Engineering Division on Sewerage and Sewage Treatment.**

177. **Earthquake Stresses in Shear Buildings,** by M. G. Salvadori.

178. **Rainfall Studies Using Rain-Gage Networks and Radar,** by H. E. Hudson, Jr., G. E. Stout, and F. A. Huff.

179. **Stiffness Charts for Gusseted Members Under Axial Load,** by John E. Goldberg.

180. **A Direct Step Method for Computing Water-Surface Profiles,** by Arthur A. Ezra.

D-123. Discussion of Paper, **Long-Period Waves or Surges in Harbors,** by John H. Carr.

D-126. Discussion of Paper, **Variation of Wind Velocity and Gusts with Height,** by R. H. Sherlock.

D-128. Discussion of Paper, **Horizontally Curved Box Beams,** by Charles E. Cutts.

181. **Slackwater Improvement of the Columbia River,** by O. E. Walsh.

182. **Hipped Plate Analysis, Considering Joint Displacements,** by Ibrahim Gaafar.

183. **Group Loadings Applied to the Analysis of Frames,** by I. F. Morrison.

184. **Dam Modifications Checked by Hydraulic Models,** by E. S. Harrison and Carl E. Kindsvater.

185. **Nonelastic Behavior of Bridges Under Impulsive Loads,** by S. J. Fraenkel and L. E. Grinter.

186. **Settling Rate of Suspensions in Solids Contact Units,** by A. A. Kalinske.

187. **The Equivalent Rectangle in Prestressed Concrete Design,** by John J. Peebles.

188. **Laminar to Turbulent Flow in a Wide Open Channel,** by W. M. Owen.

D-135. Discussion of Paper, **Application of Electronic Flow Routing Analog,** by Max A. Kohler.

D-136. Discussion of Paper, **Steady-State Forced Vibration of Continuous Frames,** by C. T. G. Looney.

189. **Snow Hydrology for Multiple-Purpose Reservoirs,** by H. S. Riesbol.

190. **Analysis of Corrective Actions for Highway Landslides,** by R. F. Baker.

191. **The Engineer's Role in Metropolitan Traffic Planning,** by Lloyd Braff.

192. **Relief Well Systems for Dams and Levees,** by W. J. Turnbull and C. I. Mansur.

193. **Velocity Measurements of Air-Water Mixtures,** by L. G. Straub, J. M. Killen, and O. P. Lamb.

D-129. Discussion of paper, **Analysis of Arch Dams of Variable Thickness,** by W. A. Perkins.

D-138. Discussion of paper, **The Value and Administration of a Zoning Plan,** by Huber Earl Smutz.

D-145. Discussion of paper, **Torsion of I-Type and H-Type Beams,** by John E. Goldberg.

194. **City Planning Techniques,** by Russell H. Riley.

195. **Special Procedures for Pavement Design,** by L. A. Palmer.

196. **Recent Airport Design and Development,** by Philip A. Hahn.

197. **Friction Factors for Turbulent Flow in Pipes,** by Edward F. Wilsey.

198. **Live Loading for Long-Span Highway Bridges,** by R. J. Ivy, T. V. Lin, Stewart Mitchell, N. C. Raab, V. J. Richey, and C. F. Scheffey.

199. **Plates with Boundary Conditions of Elastic Support,** by S. J. Fuchs.

D-134. Discussion of Paper, **Solution of an Hydraulic Problem by Analog Computer,** by R. E. Glover, D. J. Hebert, and C. R. Daum.

D-141. Discussion of paper, **Effect of Entrance Conditions on Diffuser Flow,** by J. M. Robertson and Donald Ross.

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200. **Sand Compaction by Vibroflotation,** by Elio D'Appolonia, Callix E. Miller, Jr., and Thomas M. Ware.

201. **Wind Loads on Truss Bridges,** by John M. Biggs.

202. **The Application of Heaviside's Step-Function to Beam Problems,** by John E. Goldberg.

203. **Control of Aquatic Growths in Reservoirs by Copper Sulfate and Secondary Effects of Such Treatment,** by Ray L. Derby and D. W. Graham.

204. **Engineering and Economic Problems Involved in Airport Location,** by Robert N. Cook.

205. **Bending of a Constrained Circular Beam Resting on an Elastic Foundation,** by Enrico Volterra and Randall Chung.

206. **The Effects on Structures of Winds of Hurricane Force,** by Herbert S. Saffir.

207. **Current Research in Sanitary Engineering at the University of Florida,** by David B. Smith.

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211. **Photoelastic Analogy for Non-Homogeneous Foundations,** by F. E. Richart, Jr., and Allen J. Curtis.

212. **Topographic Mapping by the U.S. Geological Survey in Florida,** by Daniel Kennedy.

213. **Hydraulic Problems of Local Interests under the Central and Southern Florida Project,** by Herbert C. Gee.

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217. **Design of Monolithic Concrete Frame —Prestressed,** by K. P. Milbradt and T. J. Kofodimos.

218. **Wind Velocities During Hurricanes,** by Robert C. Gentry.

219. **Investigation of the Dead Load Stresses in the Mississippi River Veterans Memorial Bridge at East St. Louis, Illinois,** by L. T. Wyly, R. W. Kluge, E. W. Larson, Jr., L. B. McCammon, M. B. Lagaard, and K. H. Lenzen.

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246. **Stress Measurements on the San Leandro Creek Bridge,** by Ray W. Clough and Charles F. Scheffey.

247. **The Disposal of Industrial Wastes,** by George E. Barnes.

248. **Advances in Sewage Treatment in the Period from October 1, 1951, to September 1, 1952:** Progress Report of the Committee of the Sanitary Engineering Division on Sewerage and Sewage Treatment.

249. **A Method for Calculating Stresses in Rigid Frame Corners,** by Harvey C. Olander.

250. **Numerical Analysis of Frames with Curved Girders,** by James Michalos.

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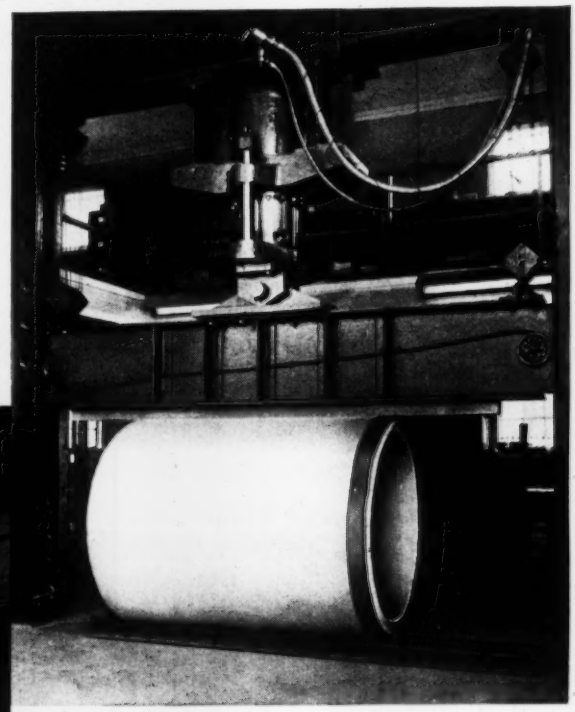

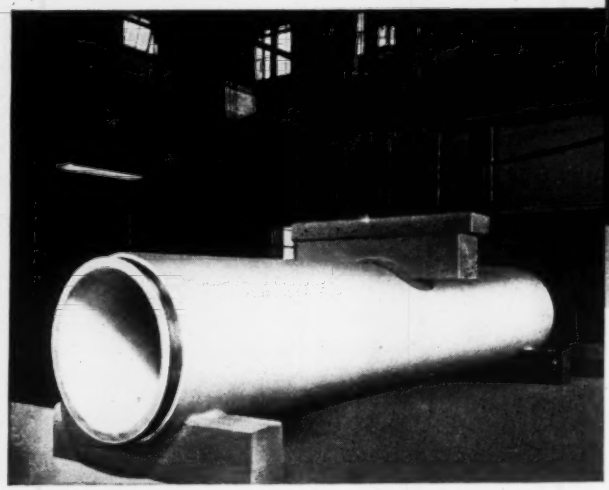

▲ *Three edge bearing test in 300,000 pound capacity testing machine.*

◀ *Determining a pipe's beam strength in 300,000 pound capacity testing machine.*

Do you have conclusive proof of the fundamental characteristics of the pipe you intend using in your next water works project? Are you certain of its advantages? Do you recognize its limitations?

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In Lock Joint's laboratory at Wharton, N. J. all guess work has been eliminated. Here, Lock Joint Pipes of all types and designs are tested to determine the exact extent of their ability to withstand back loads, beam loads and internal pressures. The most efficient modern equipment in the hands of highly trained personnel is used to give a tangible, practical demonstration of the high quality built into every type of Lock Joint Pipe.

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These constant tests of our products are your assurance that, in its field, no finer pressure pipe than Lock Joint can be produced. Built in diameters from 16″ upward and designed for any pressure common to water works practice, these pipes will serve you unfailingly for generations.

SCOPE OF SERVICES—*Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains 16″ in diameter or larger, as well as Concrete Pipes of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.*

LOCK JOINT PIPE COMPANY

Established 1905

P. O. Box 269, East Orange, N. J.

PRESSURE PIPE PLANTS: Wharton, N. J., Turner, Kan., Detroit, Mich., Columbia, S. C.

SEWER & CULVERT PIPE PLANTS:

Casper, Wyo. • Cheyenne, Wyo. • Denver, Col. • Kansas City, Mo. Valley Park, Mo. • Chicago, Ill. • Rock Island, Ill. • Wichita, Kan. Kenilworth, N. J. • Hartford, Conn. • Tucumcari, N. Mex. • Oklahoma City, Okla. • Tulsa, Okla. • Beloit, Wis. • Hato Rey, P. R. • Caracas, Venezuela

LOCK JOINT
Reinforced Concrete
PRESSURE PIPE